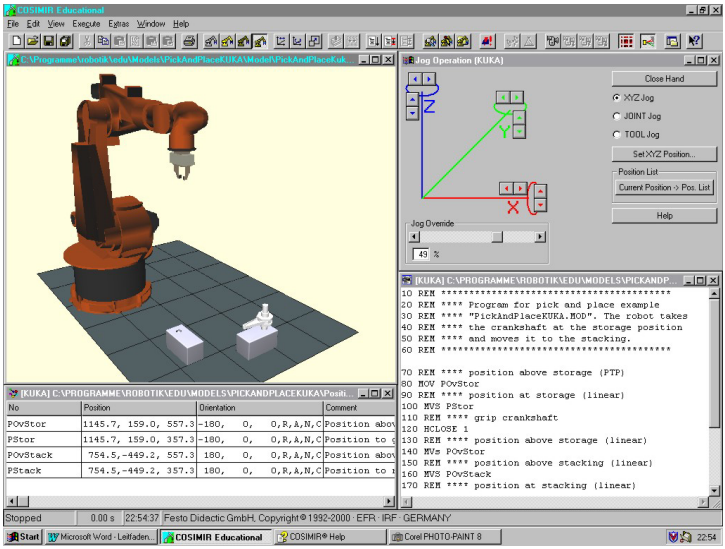
FESTO

COSIMIR®
Educational

User's Guide


COSIMIR Educational
File Edit View Execute Extras Window Help
Jog Operation (KUKA)
Close Hand
XYZ Jog
JOINT Jog
TOOL Jog
Set XYZ Position...
Position List
Current Position -> Pos. List
Help
Jog Override
49 %
[KUKA] C:\PROGRAMME\ROBOTIK\EDU\MODELS\PICKANDP...
10 REM **********
20 REM **** Program for pick and place example
30 REM **** "PickandPlaceKUKA.MOD". The robot takes
40 REM **** the crankshaft at the storage position
50 REM **** and moves it to the stacking.
60 REM **********
70 REM **** position above storage (PTP)
80 MOV POvStor
90 REM **** position at storage (linear)
100 MVS PStor
110 REM **** grip crankshaft
120 RCLOSE 1
130 REM **** position above storage (linear)
140 MVs POvStor
150 REM **** position above stacking (linear)
160 MVS POvStack
170 REM **** position at stacking (linear)
[KUKA] C:\PROGRAMME\ROBOTIK\EDU\MODELS\PICKANDPLACEKUKA\Positi...
No | Position | Orientation | Comment
POvStor | 1145.7, 159.0, 557.3 | -180, 0, | O,R,A,N,C | Position abo
PStor | 1145.7, 159.0, 357.3 | -180, 0, | O,R,A,N,C | Position to
POvStack | 754.5,-449.2, 557.3 | 180, 0, | O,R,A,N,C | Position abo
PStack | 754.5,-449.2, 357.3 | 180, 0, | O,R,A,N,C | Position to
Stopped
0.00 s
22:54:37
Festo Didactic GmbH, Copyright © 1992-2000 · EFR · IRF · GERMANY
Start
Microsoft Word - Leitfaden...
COSIMIR Educational
COSIMIR® Help
Corel PHOTO-PAINT 8
22:54

536501 EN
06/2003

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Revision level:	06/2003
Authors:	Ulrich Karras, IRF University Dortmund
Layout:	18.06.2003, Beatrice Huber

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Internet: www.festo.com/didactic
e-mail: did@festo.com

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1. Introduction

Welcome to the new 4.1 release of COSIMIR® Educational.

COSIMIR® Educational provides you with a virtual learning environment in the field of robotics. Step by step, you'll be able to advance independently from very simple robotics applications right through to highly complex workcells in a highly realistic, simulated 3D work environment.

The virtual learning environment consists of:

- Programming and simulation environment for predefined robotic workcells that represent typical industrial applications
- The Robotics Assistant online tutorial offering comprehensive robotics knowledge via multimedia presentations

The Robotics Assistant is not a CBT (computer based training), but rather a multimedia information system that provides teachers with support in designing courses of study, and that can be used by trainees for autodidactic learning.

You decide yourself how you'll proceed with your course of study. With its integrated library of workcells, COSIMIR® Educational provides you with an introduction to robotics covering various degrees of complexity. The library of workcells encompasses innumerable examples of typical industrial robotic workcells, including appropriate function descriptions and technical documentation. A sample application is included for each workcell, and instructions are provided for implementing each respective application. You can decide whether or not you'd like to install the sample solutions while installing the software. Of course you'll also have the opportunity of developing and solving a host of other tasks for any or all of the predefined robotic workcells.

The COSIMIR® Educational leaning environment provides you with user help in a number of ways. The COSIMIR® online help function is based on the standard HTML Windows help format. The Microsoft Internet explorer (version 3.0 or higher) is required in order to use the help function.

This new release incorporates many of the comments and suggestions we have received from COSIMIR® Educational users. In order to continue improving COSIMIR® Educational, we invite all future users to send us their comments, suggestions and criticism as well. We would also be happy to answer any questions that might arise regarding COSIMIR® Educational.
Just send us an e-mail at: dka@festo.com

You can also contact us by calling our telephone hotline should you experience problems while installing or using COSIMIR® Educational.

1.1 The COSIMIR® 3D simulation system

COSIMIR® is an industrial 3D simulation system for PC based operating systems including Windows 95® and 98®, as well as Windows NT®, 2000® and XP®. COSIMIR® facilitates the planning of robotic workcells, testing the reach ability of all required positions, the development of robotics and control programs, and layout optimisation. All motion sequences and handling operations can be simulated in order to rule out the possibility of collision, and to optimise cycle times.

Work-cells can be created using library components such as machines, robots, tools, assembly lines, loaders and more with the help of COSIMIR® model expansion modules. You can also create your own workcell components, and import part models and workpieces from other CAD systems such as AutoCAD®.

1.2 What's new?

We've integrated a host of new workcells into COSIMIR® Educational:

- A simple introductory workcell with Mitsubishi RV-M1 and RV-2AJ robots
- Robotic workcells from the "Basic Robotics" workbook (BP70) furnished to our initial robot customers, for taking advantage of existing learning scenarios in COSIMIR® Educational
- All robotic workcells from our new version C of MPS®:
  – Robot station
  – Robot station with assembly
  – Robot station with assembly and hydraulic punch
  including comprehensive documentation of the sample programs. Control panels are also made available as highly realistic 3D objects.
- Festo handling systems
- Robotic welding station, which is also offered as part of our CIM/FMS system

"Manual" feeding of workpieces is accomplished by means of simple, supplementary buttons. It's no longer necessary to import workpieces as new models.

The following methodology has been utilised for the workcell sample programs:

- All sample programs for Mitsubishi robots use the Melfa Basic IV programming language if supported by the utilised controller. Otherwise, MRL is used (Movemaster Command).
- All programs for workcells that do not include any Mitsubishi robots have been written in universal IRL (industrial robot language). However, Mitsubishi's Melfa Basic IV programming language can also be used with these workcells, although not all of the special Mitsubishi functions can be used in this case.

A graphic representation of the I/O assignment list for the workcell's sensors/actuators and the inputs and outputs at the robot controller can be additionally selected in the model explorer. New connections can be established by means of drag and drop within this display. Input and output statuses are displayed online by mean of colour codes in the simulation mode.

The integrated S5 soft PLC has been replaced with an S7 soft PLC. Program modules can be displayed online in the STL mode, and can be run in single-step operation. This provides for a much more clear-cut representation of strictly specified PLC functionality in several of the sample workcells.

You're not only able to modify the layout with the new COSIMIR® Educational release, you can also import new designs which have been created using COSIMIR® Industrial or COSIMIR® Professional. However, the import function does not support I/O connections, which must be set up manually after import.

1.3 Notation

Certain types of notation are used for texts, key combinations (shortcuts) and key sequences, making it easier to locate and identify different types of information.

Text formats

The following text formats are used:

Text Format	Used for
Bold	Names of commands, menus and dialogue boxes
Cursive	Place holder: text must be specified for elements using cursive formatting.
CAPITALS	Acronyms, folder names and file names: lower case letters can also be used when entering these names.
“Quotation marks”	Command options: quotation marks are also used to highlight chapter titles included as references within body text.

Notation for key combinations (shortcuts) and key sequences

Key combinations (shortcuts) and key sequences are written as follows:

Notation	Meaning
Key 1 + Key 2	A plus sign (+) between the names of the two keys means that both keys are activated simultaneously.
Key 1 - Key 2	A minus sign (-) between the names of the two keys means that they are activated one after the other.

1.4 System Requirements

Minimum Configuration	
Processor	Pentium II, 300 MHz or higher
RAM	128 MB
Hard disk space	850 MB
Operating system	Windows 95®, 98®; NT®, 2000® or XP®
Graphic card	3D acceleration and support for OpenGL, 32 MB RAM

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Recommended Configuration	
Processor	Pentium IV, 1 GHz
RAM	256 MB
Hard disk space	650 MB
Operating system	Windows NT®, 2000® or XP®
Graphic card	3D acceleration and support for OpenGL, 64 MB RAM
Monitor	17" screen with resolution of 1024 x 768 pixels

1.5 Installation

A CD and this user's guide are supplied with COSIMIR® Educational. The software can be installed in two different ways:

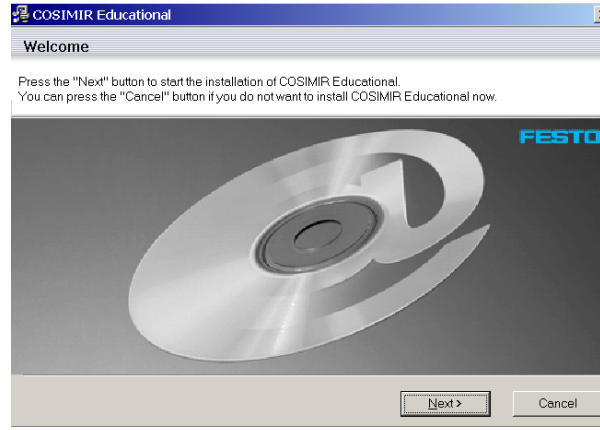
- Network installation
- Installation with online activation

Installation with **online activation**

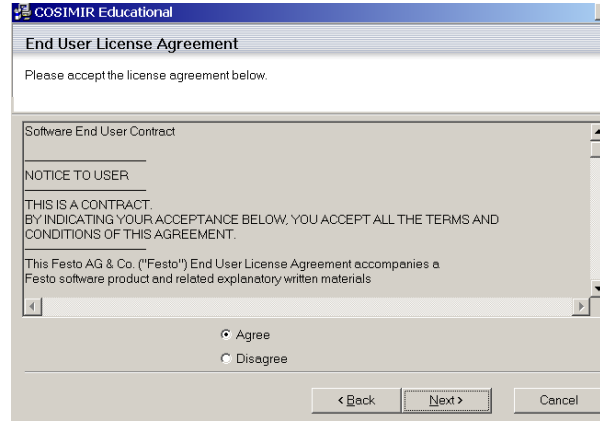
Getting started:

- Switch on your PC and start Microsoft Windows.
- Insert the COSIMIR® Educational CD ROM into the CD disk drive.
- Click **Run** in the start menu.
- Enter d:setup.exe to the entry field in the dialogue box which then appears. Acknowledge your entry by clicking the **OK** button.
- If your CD ROM disk drive has a designation other than "d:", the letter "d" must be replaced with the appropriate designation.

The installation program's initial window appears:


COSIMIR Educational
Welcome
Press the "Next" button to start the installation of COSIMIR Educational.
You can press the "Cancel" button if you do not want to install COSIMIR Educational now.
FESTO
Next >
Cancel

Follow the instructions that appear at the screen. If you are uncertain about how you should answer any given question, click either **Back** or **Next**.


COSIMIR Educational
End User License Agreement
Please accept the license agreement below.
Software End User Contract
NOTICE TO USER
THIS IS A CONTRACT.
BY INDICATING YOUR ACCEPTANCE BELOW, YOU ACCEPT ALL THE TERMS AND CONDITIONS OF THIS AGREEMENT.
This Festo AG & Co. ("Festo") End User License Agreement accompanies a Festo software product and related explanatory written materials
Agree
Disagree
< Back
Next >
Cancel

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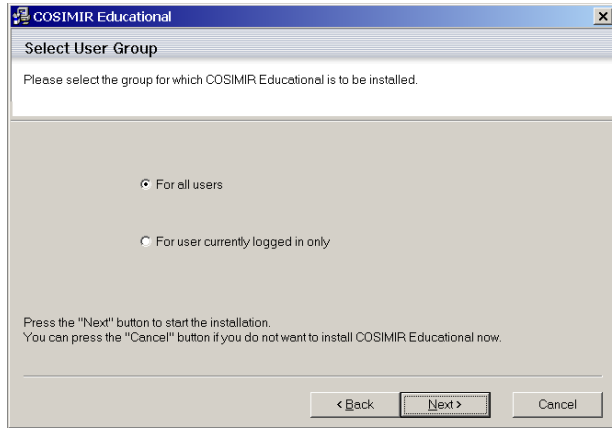
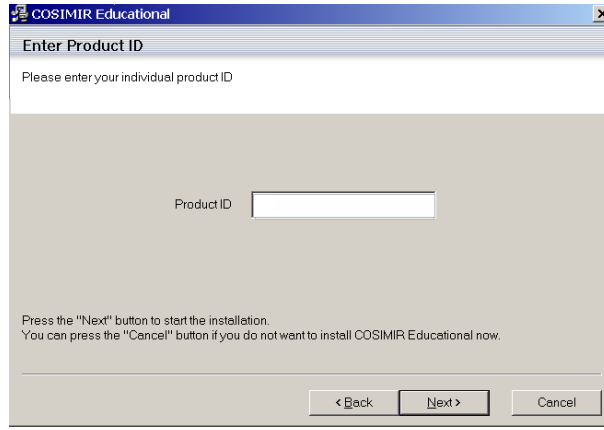
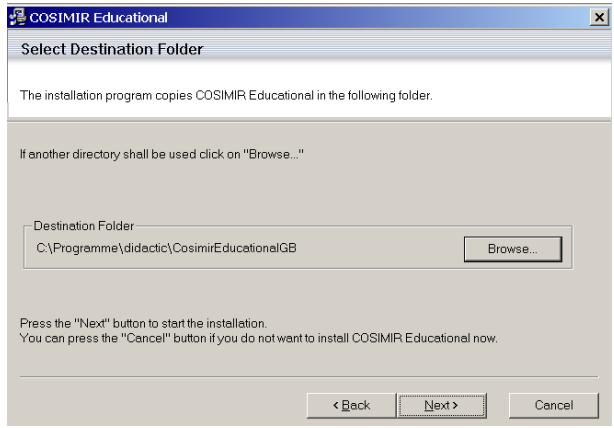
The Festo Didactic license agreement is displayed first. You must accept the license agreement in order to continue installing the software. Click **Agree**, and then click the **Next** button.


COSIMIR Educational
Select User Group
Please select the group for which COSIMIR Educational is to be installed.
For all users
For user currently logged in only
Press the "Next" button to start the installation.
You can press the "Cancel" button if you do not want to install COSIMIR Educational now.
< Back
Next >
Cancel

Now you are provided with the option of installing the software for a single, currently logged on user only.


COSIMIR Educational
Enter Product ID
Please enter your individual product ID
Product ID
Press the "Next" button to start the installation.
You can press the "Cancel" button if you do not want to install COSIMIR Educational now.
< Back
Next >
Cancel

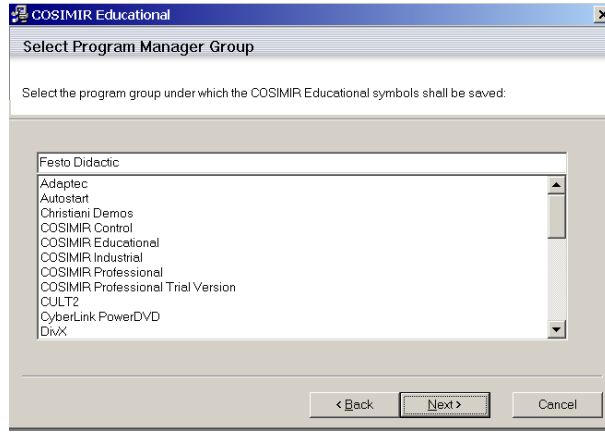
This dialogue box prompts you to enter your product ID. The product ID is a 12-place character string which is printed on the back of the CD sleeve.
If the product ID is entered incorrectly, a message appears prompting you to enter a valid product ID.


COSIMIR Educational
Select Destination Folder
The installation program copies COSIMIR Educational in the following folder.
If another directory shall be used click on "Browse..."
Destination Folder
C:\Programme\didactic\CosimirEducationalGB
Browse...
Press the "Next" button to start the installation.
You can press the "Cancel" button if you do not want to install COSIMIR Educational now.
< Back
Next >
Cancel

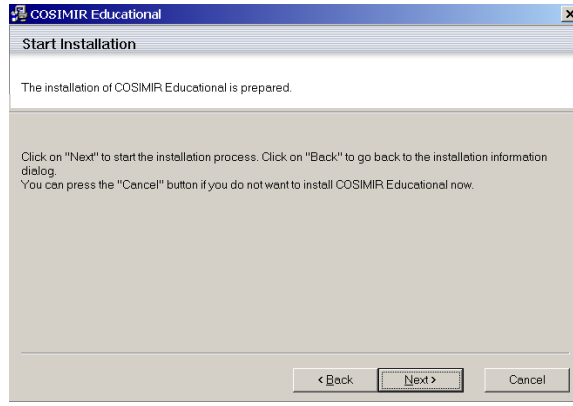
You can select the folder to which COSIMIR® Educational will be installed in the **Directory path** dialogue box.
C:\Programs\didactic\CosimirEducationalGB appears automatically as a default directory path. If you would like to install the software to another folder, click the **Browse** button.

Note

In any case, you should select a folder that does not contain any other versions of COSIMIR®.

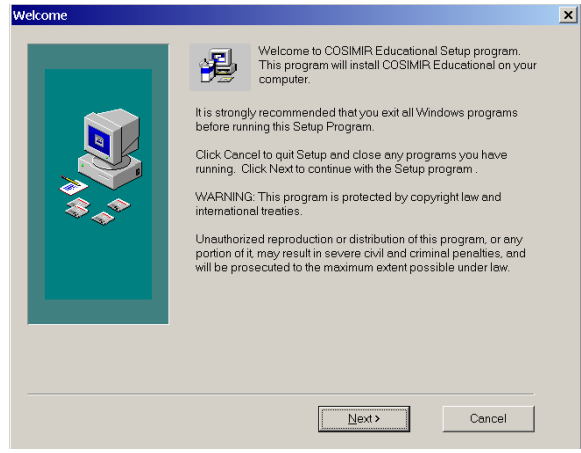


You are also provided with the option of selecting a program group to which the COSIMIR® Educational icons can be saved. Festo Didactic appears automatically as a default program group, which you can of course rename if you wish.


COSIMIR Educational
Start Installation
The installation of COSIMIR Educational is prepared.
Click on "Next" to start the installation process. Click on "Back" to go back to the installation information dialog.
You can press the "Cancel" button if you do not want to install COSIMIR Educational now.
< Back
Next >
Cancel

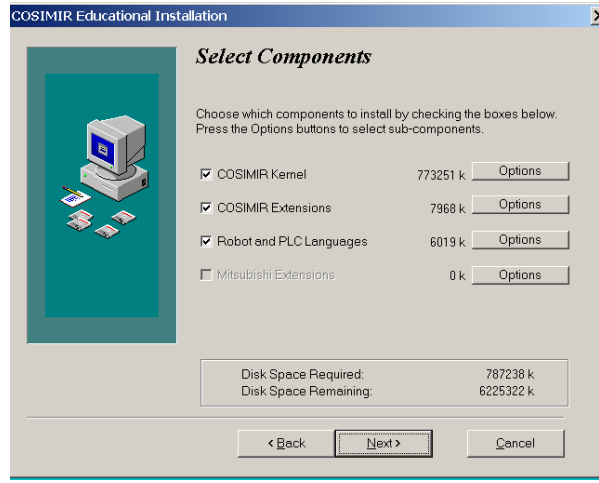
COSIMIR® Educational is now ready to be installed. Click the **Next** button in order to start installation.

Installing COSIMIR®

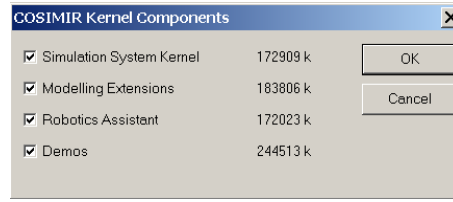

Welcome
Welcome to COSIMIR Educational Setup program. This program will install COSIMIR Educational on your computer.
It is strongly recommended that you exit all Windows programs before running this Setup Program.
Click Cancel to quit Setup and close any programs you have running. Click Next to continue with the Setup program .
WARNING: This program is protected by copyright law and international treaties.
Unauthorized reproduction or distribution of this program, or any portion of it, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under law.
Next >
Cancel

The initial window for the COSIMIR® Educational installation program appears.

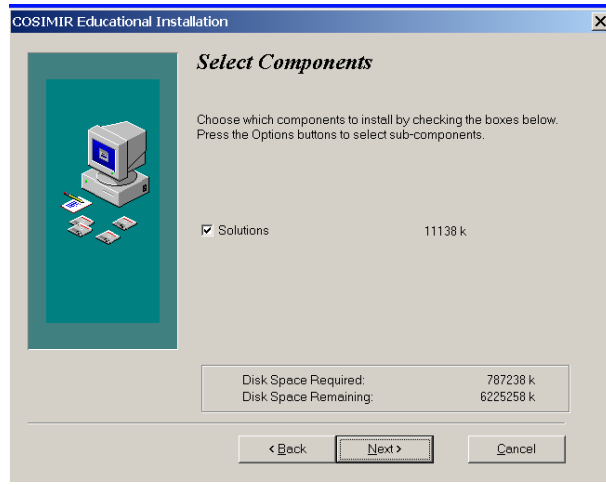
COSIMIR® Educational can be installed along with two supplementary options, which can be selected in the following dialogue box:



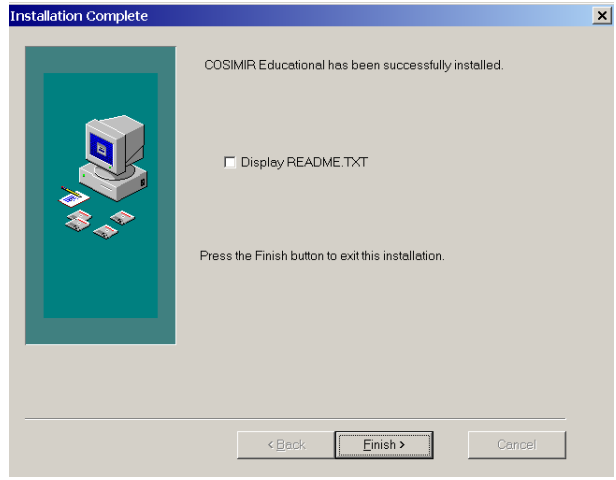
We recommend to use the default settings. Click the **Option** button of COSIMIR® Kernel. Following dialog box will appear:



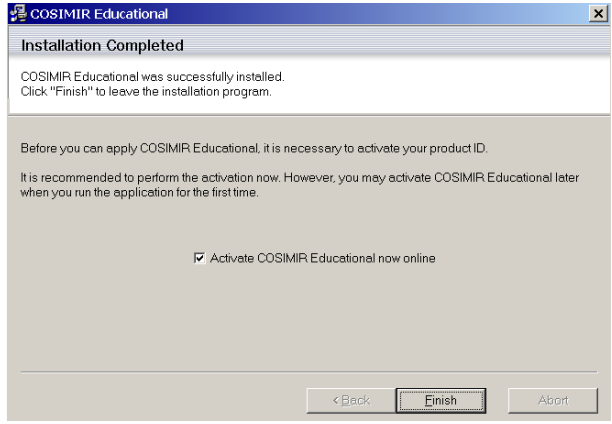
The examples include predefined robotic workcells with comprehensively described tasks. Click the **OK** button. You will be asked to confirm following selection:



The corresponding solutions can also be installed.

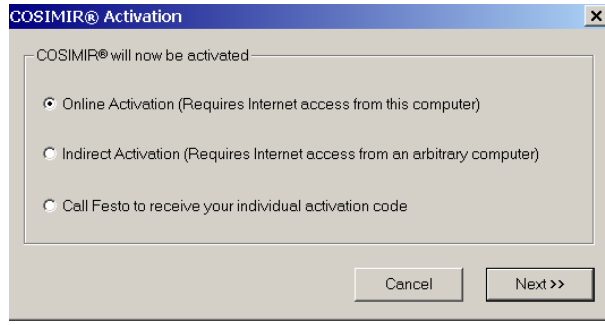


A message appears indicating that COSIMIR® Educational has been installed successfully. Click the **Finish** button.


COSIMIR Educational
Installation Completed
COSIMIR Educational was successfully installed.
Click "Finish" to leave the installation program.
Before you can apply COSIMIR Educational, it is necessary to activate your product ID.
It is recommended to perform the activation now. However, you may activate COSIMIR Educational later when you run the application for the first time.
Activate COSIMIR Educational now online
< Back
Finish
Abort

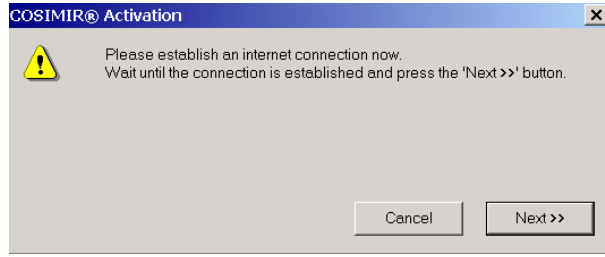
Software installation has now been completed. Now you'll need to decide whether you want to activate your license immediately, or later.

Online activation


COSIMIR® Activation
COSIMIR® will now be activated
Online Activation (Requires Internet access from this computer)
Indirect Activation (Requires Internet access from an arbitrary computer)
Call Festo to receive your individual activation code
Cancel
Next >>

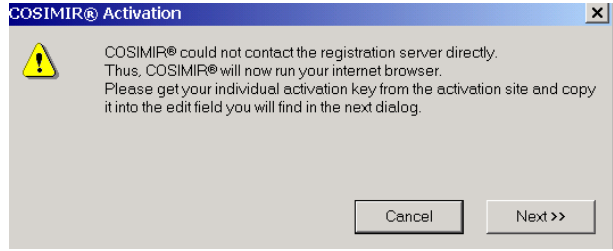
Various options are available for enabling your license. We recommend using the direct online activation option. Indirect online activation can be executed from a separate PC, or you can request your activation code on the phone.
However, this telephone service is only available from
Monday through Friday, from 8 a.m. to 10 p.m. central European time.

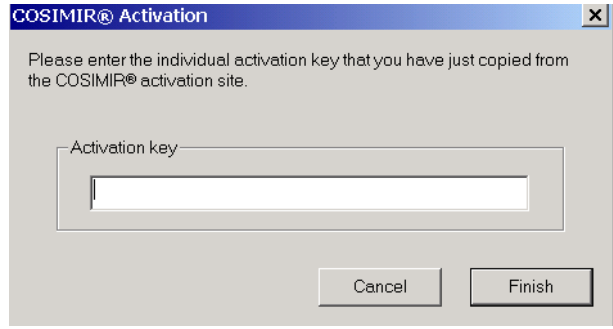
If you decide to use the direct, online activation option:


COSIMIR® Activation
Please establish an internet connection now.
Wait until the connection is established and press the 'Next >>' button.
Cancel
Next >>

You are prompted to establish a connection with the Internet, after which your license is enabled automatically.

The following dialogue box appears if your PC is equipped with a firewall that prevents incoming communication via the Internet:


COSIMIR® Activation
COSIMIR® could not contact the registration server directly.
Thus, COSIMIR® will now run your internet browser.
Please get your individual activation key from the activation site and copy it into the edit field you will find in the next dialog.
Cancel
Next >>


COSIMIR® Activation
Please enter the individual activation key that you have just copied from the COSIMIR® activation site.
Activation key
Cancel
Finish

Your activation key appears in the display shown above. Select this number and copy it to the clipboard with the key combination Ctrl+C, and then paste it to the **COSIMIR® activation** dialogue box with the key combination Ctrl+V. Click the **Finish** button in order to complete license enabling.

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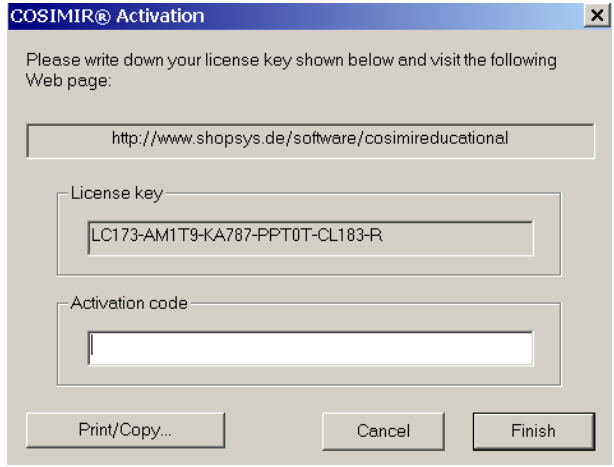
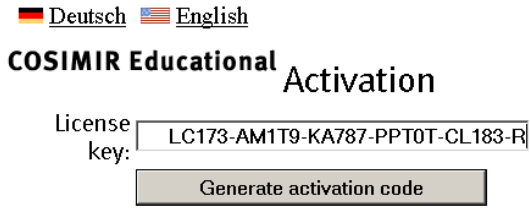
Indirect activation

The following dialogue box appears if you select the indirect online activation option for inquiring at a separate PC:



Access the website at the specified web address from a separate PC. The following display appears:

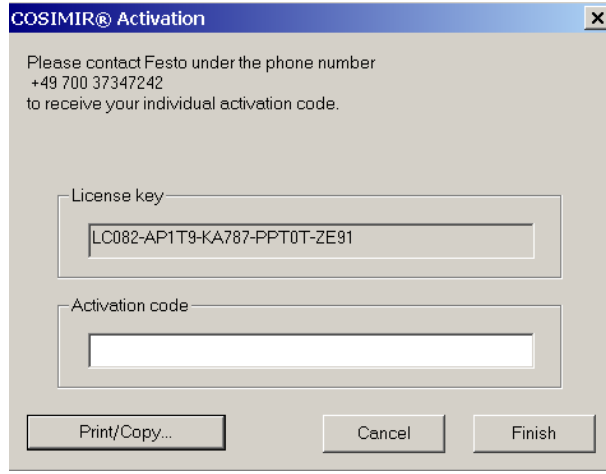


Copy the license key into the appropriate entry field and click the **Generate enable code** button.

The activation code appears. Copy this code and enter it in the appropriate field at the PC to which the software has been installed.

Telephone inquiry

If you decide to request your enable code on the phone:



Call the phone number shown in the above dialogue box. You'll be asked for the license key.

You may save the license key. Click the **Print/Copy...** button. Following options will be offered:

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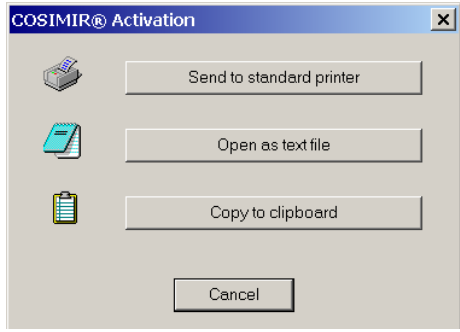


You'll receive your enable code in return, which must be entered to the appropriate field. Click the **Finish** button in order to enable your license.

Multiple License

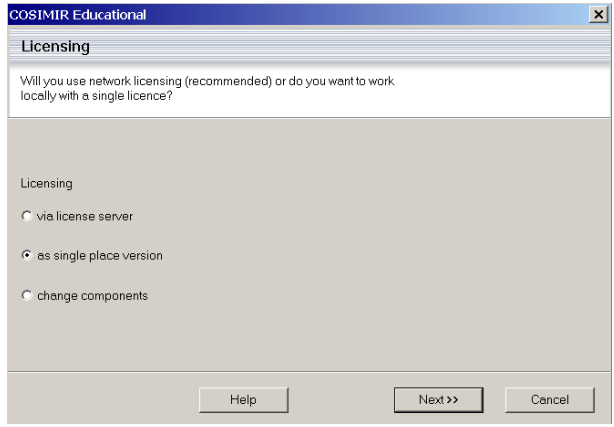
If you've purchased a multiple license, each installation must be enabled separately. Each time an installation is enabled, a message appears indicating how many licenses can still be issued with the specified product ID.

Network installation

Most importantly, the term network installation makes reference to software licensing which is executed via a network from a central license server. A green license dongle is required for network installation. Licensing of the individual installations is executed dynamically, and licenses can be requested from any workstation within the network until the ordered number of licenses has been allocated. The license server is a PC within the network that executes the licensing procedure. The license dongle must be plugged into the parallel port of the license server, and must be accessible to all licensed workstations at all times.

Single workstation

Single workstations can also be licensed locally. Start installation as described above, and the following initial window appears:



Select the second option in order to license a single workstation. Proceed with installation as described above.

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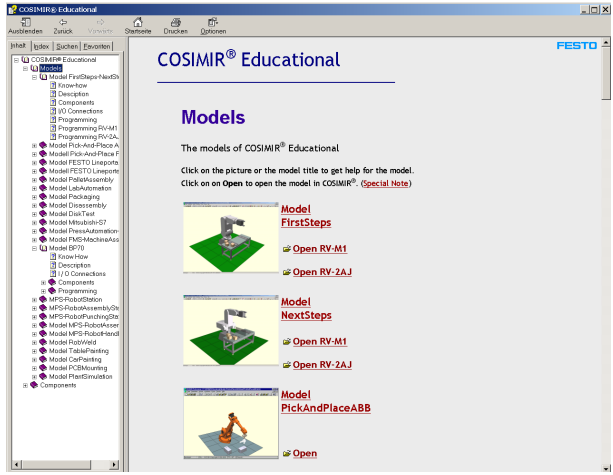
After installation has been completed, additional COSIMIR® program components can be installed with the help of the **Change components** option.

License server

If you want to licence a workstation via a licenser server, carefully read the included network installation instructions first.

1.6 Special Notes

When you access a model for the first time from the help function, a dialogue box appears for downloading files. Notes on working with this dialogue box can be displayed by clicking the (Special Note) link in the model help window:



Known conflicts with other programs:

Winamp

As a standard function, Winamp registers file types with the “.mod” extension in a protected mode. This makes it impossible to open models from the help function. If Winamp has already been installed on your PC, it must first be deinstalled, and then reinstalled with a different option setting. Click the (Special Note) link to this end. A display appears which includes a further link: (Known Conflicts). Click the (Known Conflicts) link for a complete description of the correct option settings required for Winamp.

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2. The COSIMIR® Educational Concept

2.1 Didactic Concept

COSIMIR® Educational software is based upon the concept of an open learning environment.

Open learning environment means:

- An open approach to learning characterised by constructivism, i.e. various tools including basic knowledge, a lexicon and simulations are made available which can be combined and utilised as desired in accordance with your own learning objectives.

This open concept has also been implemented in organising the basic knowledge. The central topic is robotics, which is why we call it the "Robotics Assistant". It's not laid out as a CBT or a WBT, but rather as an interactive, multimedia knowledge and information system. The contents of the program are presented as individual information modules including:

- Texts (concepts, explanations, regulations, examples etc.)
- Graphics
- Videos and animations

The information modules are interconnected by means of hyperlinks.

The Robotics Assistant provides you with various options for accessing information in a targeted fashion:

- Searches for keywords or topics
- Tree structure navigator
- List of selected topics

Selected information can also be printed out at any time.

Why have we selected this open concept for imparting knowledge?

- We do not perceive the acquisition of knowledge and information as an end unto itself, but rather as a necessity for solving problems.
- The project task or the problem to be solved are at the heart of our concept, resulting in the need to acquire new knowledge in order to solve the problem at hand.
- Acquiring knowledge and information with modern methods based on software technology is one of the central learning tasks in today's technological society.

A further didactic concept is the provision of virtual work environments in the form of simulated robotic workcells. These are represented in 3 dimensions in order to create as realistic an image as possible.

- Options for experimenting with the workcells effectively place the trainee in a close relationship to the object under study. Knowledge is tested and reinforced.
- Realistic experience provided by the workcell gives rise to a new quality of knowledge: theoretical knowledge is transformed into practical application and skills.
- The workcells promote learning by discovery at different levels of difficulty (it works, it doesn't work, it works more efficiently etc.).

2.2 Approach and Learning Goals

Robotics is a fascinating, but at the same time highly complex and intricate technology. We restrict ourselves here to the field of industrial robotic systems, and the area of mobile robotics will not be addressed at all.

Target groups and prerequisites

Our approach is aligned to vocational training in the following areas:

- Mechatronics
- Various technical qualifications for metalworking and electrical engineering
- Information technology

Our approach is aligned to technical colleges and universities. We also assume that you, the trainee, are familiar with the Windows PC environment.

Trainees must be equipped with certain basic knowledge in order to get started in the field of robotics. The Robotics Assistant provides comprehensive basic knowledge on the subject of industrial robots (see chapter 2.1 above). The Robotics Assistant makes it possible for the trainee to:

- Acquire basic knowledge independently, and in a targeted fashion
- Prepare for problem solving tasks
- Retrieve, and if necessary print out additional information during the problem solving stage

We also provide teachers with the opportunity of using the Robotics Assistant as a multimedia supplement to their own course. Thus COSIMIR® Educational assists you in organising the basics for your projected learning approach in a highly flexible way right from the beginning of the introductory phase. We recommend covering at least the following subjects with the Robotics Assistant for introductory courses:

- Definition of robots including characteristic values
- Robot design with subchapters covering hardware, different types of robots and work safety
- Robot programming languages

That which has been read or heard can then be subjected to practical testing, analysed and implemented by the trainee in his work with the numerous virtual robotic workcells. Of course we are aware of the fact that a virtual workcell is not capable of imparting all of the many aspects of this technology. Problems associated with drive technology, accuracy and dynamics are not taken into consideration in the simulations. For this reason, we also offer the respective hardware environments for several of the workcells:

- BP70
- MPS® RobotStation
- MPS® RobotAssemblyStation
- MPS® PunchingStation
- FMS-MachineAssembly
- RobWeld

An ideal learning environment can be created with these workcells by fulfilling the following basic requirements:

- At least one real robotic workcell
- One workstation (learning station) with a COSIMIR® Industrial (or COSIMIR® Professional) license
- Each trainee has their own COSIMIR® Educational license

In this way, each trainee has the opportunity of downloading their program to the robot controller at the real workcell, and can start up and run their own solution to the specified problem at the actual system.

2.3 Learning via Virtual Workcells

The virtual workcells create an experimental environment for trainees, allowing them to experience and grasp the required basic knowledge. At the same time, they are a point of departure for the examination of new questions and problems, i.e. for building upon existing knowledge.

The educational portion supplies you with descriptions of all of the robotic workcells, and the graphic navigator (see figure 2.1) provides you with direct access to all applications. The descriptions of each of the respective workcells can be opened by clicking the image of the appropriate models in the graphic navigator:

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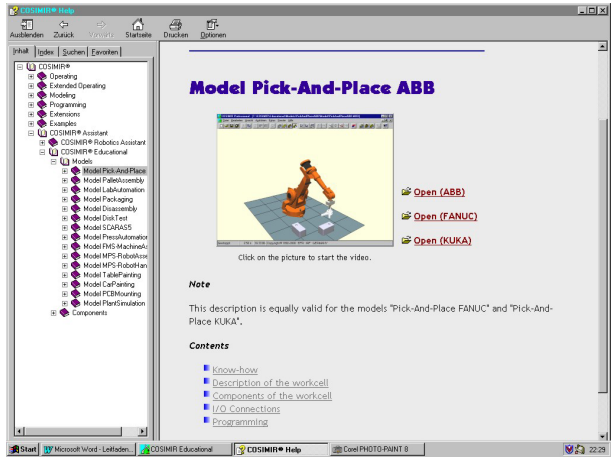

Figure 2.1: Model description

An animation is started by clicking the model image, and the respective workcell is demonstrated by means of a simulation sequence. The trainee is thus provided with visual support in addition to the workcell's function description. The following additional information can be displayed:

- **Learning objectives (know how)**:
  Here we've listed the typical learning objectives that can be realised with the respective workcell as examples. Of course it is also possible to establish additional objectives with the selected robotic workcell, depending upon the specified tasks.
- **Description of the workcell**:
  This section provides a function description of the workcell, creating the basis for the generation of one's own tasks.
- **Components of the workcell**:
  This section contains a brief technical documentation of the most significant components included in the respective workcell.

- **I/O connections**:
  Here you'll find a commentated list of I/O assignments for the robot controller, as well as for the PLC if included.
- **Programming**:
  The structure of the sample program is explained, and helpful hyperlinks and tips are provided for program writing.

In addition to, and independent of the included hyperlinks, you can also access any explanations of terminology and basic theory which you deem necessary for your problem solving task at any time with the help of the assistant explorer or the index and search functions.

Introductory workcell

Which workcell should you start with? If you have no previous robotics knowledge, we recommend beginning with the "First Steps" and "Next Steps" models. In the First Steps workcell, simple rectangular workpieces can be picked up from a table, moved to a pallet, and finally positioned on a second pallet. A glass plate is located between the two pallets in the Next Steps workcell, and an alternate position must thus be added to the pick & place sequence in order to avoid possible collision.

Work-cells with either the Mitsubishi RV-2AJ robot or the RV-M1 predecessor model can be selected. The RV-2AJ can be programmed with the modern, high-level Melfa Basic IV robot language, whereas the simple command language, Movemaster Command (MRL), must be used with the older RV-M1. We only recommend the model with the RV-M1 robot if your hardware environment also includes RV-M1 robots.

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Before writing a robot program, you must first learn to move the robot and actuate its gripper. The robot can be moved within various coordinate systems:

- Joint coordinates
- World coordinates
- Tool coordinates

The various coordinate systems can be visualised in the workcell window. Robots can be set into motion with a so-called teach panel. A universal control module is also replicated in the simulation by means of the teach-in window and can also be used to move the robot. For example, attempt to move the robot by simply changing the axis coordinates such that it is able to securely grasp a workpiece with its gripper.

Three-dimensional navigation

Three-dimensional navigation within the workcell presents you with an additional problem. The representation of the workcell changes depending upon the point of view:

- From the top left or top right
- From the front or the back
- From up close or far away

At least two different views are required for trouble-free, three dimensional orientation. With COSIMIR® Educational, the number of views is only limited by the performance characteristics of your PC.

Robot motion

You'll discover that it's quite advantageous to make use of motion within the other coordinate systems in order to grasp a workpiece. On the other hand, each movement executed by the robot is the result of coordinated motion of the individual joints. These can be viewed in the status window, for example in order to observe the means by which axes must be moved in order to advance the gripper along the X-axis in the world coordinate system. In order to execute the gripping operation, the gripper must be appropriately oriented. Consider whether or not restrictions would result in this area through the use of a 5-axis articulated robot?

The position list

Now that you've brought the robot into a position from which it can grasp the workpiece with its gripper, you can save this point to the position list. The position list contains all of the points to which the robot must move directly for a given program, as well as important ancillary points for moving along a path (mid-point, diverging point etc.). Why is a position list so important? One could argue that as long as the cell is known, any desired point can be calculated. Why, then, should the robot first move to certain teaching points? The answer is quite simple: As a rule, industrial robots demonstrate very good repetition accuracy, but their absolute positioning accuracy is entirely inadequate for most applications. Further details are included in the Robotics Assistant.

One of the main tasks during commissioning of a robotics application is testing the position list, i.e. positions established in the simulation are tested via the real system, and are modified if necessary. It is thus extremely important for trainees to become well acquainted with the teach-in procedure in the simulation.

Each workcell has its own position list which you can take advantage of in order to reduce the time required for teaching in all of the positions.

The first robot program

As is also the case with the teach-in procedure, two different types of motion commands are also used for programming robot motion:

- Movement from a starting point to an end point, which is known as point-to-point movement (abbreviated PTP). The actual path to the robot's end point is not defined, because all axes travel to their end-positions independent of one another.
- Movement of the robot to the end point via a predefined path (for example along a straight line).

Sample task

The blue workpiece in the First Steps model must first be set onto the middle section of the first pallet. After a waiting period of 2 seconds, it must then be sorted into the bottom section of the second pallet.

Sequence plan

First, a sequence plan is created for the program:

1. The robot's gripper is open.
2. The robot moves the gripper to the gripping position (blue workpiece) with a PTP movement.
3. The gripper is closed.
4. The robot moves the gripper to the middle section of the first pallet with a PTP movement.
5. The gripper is opened.
6. The robot moves linearly back to a point above the first pallet.
7. 2 second waiting period
8. The robot moves the gripper back to the middle section of the first pallet (linear movement).
9. The gripper is closed.
10. The robot moves the gripper to a point above the final position with a PTP movement (for safety reasons).
11. The robot moves the gripper to the final position (linear movement).
12. The gripper is opened.
13. The robot returns to its initial position with a PTP movement.
14. End

Of course the robot's controller is unable to understand this text, which must be translated step by step into, for example, the Melfa Basic IV programming language:

```
10 HOPEN 1
20 MOV P1, -30 "P1 = gripping position"
etc.
```

The sequence plan should be laid out such that each step can be implemented by means of a command or a subprogram. At the same time, the sequence plan provides you with ideal documentation of your program. Details regarding Mitsubishi programming languages can be found in the “Programming” chapter included in the COSIMIR® help function.

Downloading to the robot controller

The program has now been created, and must be downloaded to the robot controller. This procedure can be replicated in COSIMIR® Educational, because the simulation includes a fully fledged robot controller. The downloading procedure is completed in two steps:

- Compile the program, i.e. the syntax of the programming language is checked and is translated into universal IRDATA machine code.
- The machine code is downloaded to the robot controller, i.e. the code is linked to the controller.

Any errors that might occur are displayed. The details for this procedure are presented in chapter 4.2.

Simulation

The program has now been downloaded without error to the robot controller. Start the program and observe the 3D motion sequence. You can select either the
– automatic mode
or the
– single step mode,
and you’re able to determine whether or not the sequence is executed in a logically and functionally correct fashion.

Collision detection

If the sequence is error-free, you should then check to see if any undesired collisions occur. The Next Steps model is used to illustrate this procedure, which includes an additional glass plate between the two pallets. Start collision detection (see chapter 5.2), and then start the above described program. If a collision occurs, the robot’s path must be suitably changed. Check to see whether or not any other collisions might occur during the sequence. Why, for example, does the

robot move to a point above the final position for safety reasons in the above represented sequence plan? Check the other movements and gripping positions with this in mind.

Flexibility in designing tasks

Various problems can be posed for each of the workcells. The layout of any given workcell can be readily changed with the help of the model explorer (see chapter 6.3), for example the pallets or the workpieces in the First Steps model can be repositioned. Can the tasks still be completed after repositioning? Additional components can also be imported to the workcell (see also chapter 6.4).

If you use a Kuka, an ABB or a Fanuc robot in your laboratory environment, you can use the ABB Pick & Place, FANUC Pick & Place and KUKA Pick & Place models as alternative introductory workcells.

The IRL programming language

Robot systems from various manufacturers use different programming languages, although there is a standardised, universal robot programming language known as IRL (industrial robot language). We have selected the following didactic solution for COSIMIR® Educational:

- We offer the Melfa Basic IV high-level programming language or the simple MRL command language for all robotic workcells with Mitsubishi robots.
- If the workcell does not include any Mitsubishi robots, we offer the standardised IRL language. Please note that the robots in these cells can also be programmed with Melfa Basic IV, but not all of the language's attributes will be supported in this case.

Keep in mind that IRL is a significantly more complex language than Melfa Basic IV. Details regarding IRL are included in the COSIMIR® help function under "Programming".

Sensor technology

A robot can only be used flexibly if it is capable of communicating with its work environment. The analysis of sensor signals is utilised to this end. We have provided numerous workcells for this purpose. We recommend the BP70 model, and in particular the MPS® RobotStation, for getting started with this subject matter. In this workcell, the positions of objects are detected by the robot in an elementary way, and are evaluated for further processing. You can make use of a simulation box with 8 inputs and outputs that are connected to the robot's controller in the BP70 workcell.

2.4 The Workcells

The sequence in which the workcells are laid out is organised such that, as a rule, knowledge gained in working with previous workcells is very helpful in solving the problems posed by subsequent workcells. However, if the trainee has prepared himself adequately, the workcells can be processed in any other desired order. In any case, before you begin work with any given workcell, you should carefully examine the respective video animation, as well as instructions regarding programming and I/O connections, and included component descriptions.

FirstSteps/NextSteps

These robotic workcells have already been described in detail in chapter 2.3. They are available with RV-2AJ and RV-M1 robots. The sample programs for the RV-2AJ have been created with Melfa Basic IV, and for the RV-M1 with MRL.

PickandPlaceABB.mod

The PickandPlaceABB.mod workcell includes a very simple handling task with a type 2400-16 ABB robot, which serves as a basis for all further tasks. Simple examination of the working space can be executed with this workcell by repositioning the robot and the pick & place library component. For the purpose of introduction, this workcell is also available for Fanuc S700 and Kuka KR125Z robots. Please note that it is very easy to replace the robot included in the workcell with any other robot from the robot library (see also chapter 6.4). The sample programs are written in IRL.

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PickandPlaceFesto	A similar handling task is implemented with this workcell using a Festo 2-axis pneumatic linear system. This model is also available with sensors that detect the objects to be handled. The sample program is written in IRL.
Festo linear gantry	The linear gantry in this workcell is equipped with a double gripper system. It is thus capable of simultaneously removing two crankshafts from different workpiece holders, and transferring them to different destinations. The sample program is written in IRL.
FESTO Linear gantry with conveyor belt	This workcell additionally includes two conveyor belts. Two crankshafts are removed from a container. However, the container is closed and the gantry system must wait until it has been opened. The two crankshafts are then removed and each is transferred to a conveyor belt, by means of which they are taken away.
BP70	This workcell is available with the Mitsubishi RV-M1 robot, as well as the RV-2AJ. It additionally includes two workpiece holders, one tool holder with tool, a pallet with workpieces and a simulation box with 8 inputs and outputs. A large number of different tasks can thus be executed with the workcell: • Handling task • Machining task • Palletising task The tasks section in our “Basic Robotics” workbook includes concrete task suggestions. This was the first robotic workcell offered by Festo as part of the MPS® product range.

MPS® RobotStation

This workcell is a simulation of the new MPS® Robot Station, and is equipped with the RV-2AJ robot. Geometric data are based upon a CAD import of the associated design engineering data. The station performs the following task sequence:

- Determine the material characteristics of a workpiece held by the robot's gripper with the help of a sensor.
- Remove workpieces from the seat in a chute after a signal has been generated.
- Detect the position of workpieces and set them down correctly orientated at an assembly point.
- Sort workpieces into magazines according to material characteristics.

This is the standard MPS® robotic workcell. The sample program is written in Melfa Basic IV.

MPS® RobotHandling

The MPS® RobotHandling.mod workcell is a simulation of the MPS® "Robot Handling" Station from Festo Didactic. It was the predecessor of the above described station. Different types of housings must be sorted into magazines using this workcell. The housings are either on a pallet or in a storage bin. If the robot is to remove a housing from a storage bin, the housing has to be added first by means of the import function. The sample program is written in Melfa Basic IV.

MPS® RobotAssembly

The MPS® RobotAssembly.mod workcell is a simulation of the MPS® "Robot Assembly" station from Festo Didactic. It is available with the 6-axis Mitsubishi RV-E2 robot, as well as the new 5-axis Mitsubishi RV-2AJ. It is the task of the robot to completely assemble various cylinders from individual parts. The appropriate cylinder housing must be fed to the robot to this end by importing the respective model from the "Import" folder. The sample programs are written in Melfa Basic IV for the RV-2AJ, and in MRL for the RV-E2.

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MPS®
RobotAssemblyStation

This workcell is a simulation of a combination including the new MPS® “Robot” and “Assembly” stations. The combination replaces the above described assembly station. The “Assembly” station is controlled by a simulated S7 PLC, or by the robot controller. A comprehensively documented sample program is available for both variants. The programs are identical to the respective programs for the real robotic workcells. The task consists of assembling model cylinders from the following components:

- Cylinder housing
- Piston
- Spring (piston return spring)
- Cylinder cap

Through the use of various cylinder housings (red, black and silver), it is possible to assemble various cylinders with different piston diameters (identified by the colours black and silver).

MPS®
RobotPunchingStation

This workcell is a virtual representation of a combination including the three MPS® stations “Robot”, “Assembly” and “Hydraulic Punch”. As before, the “Assembly” station is controlled by a simulated S7 PLC or the robot controller. The hydraulic punch is controlled by a simulated S7 PLC. The hydraulic punch produces the cylinder caps in this combination station. Blank caps are fed to the punch from a cap magazine. The hole for the piston rod is then punched into the cylinder cap and the cap is set into a tray.

PalletAssembly	The PalletAssembly.mod workcell includes a Mitsubishi RV-2AJ robot, that has the task of filling a pallet with workpieces. This is also a handling task, but robot movements take place to calculated positions as well as to predefined positions in this case. For this task, it is also useful to introduce the programming of loops. Feeding workpieces from a magazine necessitates additional I/O interrogations. The sample program is written in Melfa Basic IV.
LabAutomation	Gripper changeover systems must be taken into consideration with the LabAutomation.mod workcell. It must be determined whether or not a new TCP needs to be calculated. Various tasks must be executed with the various gripper systems, which have to be organised via I/O communication. It is useful to elucidate the use of subprograms and counters for the programming of this workcell. 6-axis Mitsubishi RV-E2 robots are used. The sample program is written in MRL.
Packaging	A SCARA robot equipped with a vacuum gripper is utilised in the Packaging.mod workcell. Beyond this, a conveyor belt and the creation of additional packages must also be controlled. Removing packages from the conveyor belt is controlled by means of I/O communication. The sample program is written in the standardised IRL robotics language. The integrated programming assistant can be exploited, which provides considerable help in creating an initial program.
Disassembly	The bolts must be removed from an automobile wheel using a Reis RV-16 robot in the Disassembly.mod workcell. An inductive sensor is used to determine whether or not the robot is using the right socket wrench to remove the bolts. Programming must be written in IRL. Knowledge of procedural and modular programming must be acquired. Sensor interrogations must also be incorporated into the communications sequence in this workcell.

Disktest	Hard disks are tested at four different stations with the Disktest.mod workcell. The test stations perform a surface inspection of the metal coatings on the disks. This task can be expanded with a requirement for calculating the Cartesian coordinates of the disks, and corresponding organisation of generated workcell data into data structures as part of the programming.
Mitsubishi-S7	A Mitsubishi RH-5AH55 SCARA robot communicates with a PLC in this workcell. The robot must execute simple handling tasks based upon PLC commands. The robot and the PLC are connected to one another via digital inputs and outputs to this end. The sample program is written in Melfa Basic IV.
FMS-MachineAssembly	The FMS-MaschineAssembly.mod workcell simulates a Festo Didactic FMS system. Four different processes can be executed. Depending upon the process, a given workpiece holder is fed to the workcell on a conveyor belt. The workpiece holder must be added to the model by clicking the appropriate button. The following points outline the most important new learning content included in this workcell: • Accurate teach-in of difficult to access positions • Collision-free path planning in very tight spaces • Control of the functional units included in an EMCO CNC milling machine • Complex I/O communication • Initialisation of robot subprograms based upon sensor detection of the type of workpiece fed to the system

PressAutomation	Press linking is accomplished by means of two type KUKA KR 125 industrial robots and a simulated S7 PLC in the PressAutomation.mod workcell. In addition to communication with the PLC via digital inputs and outputs, the work procedures of two robots must be synchronised as an additional challenge in this case. The sample program is written in IRL.
RobWeld	This workcell simulates the actual Festo Didactic FMS welding station. Welding is performed by a Kawasaki FS03N robot. The gripper system consists of a pneumatic 3-finger gripper and a welding torch, which is connected to the robot flange via a collision-shutdown device for safety reasons. The task is to weld three raw metal components together into a cylinder housing. This can be accomplished by means of spot welding or path welding. The sample program is written in IRL, and executes a spot welding sequence. A glass shield for the prevention of electro-ophthalmia must be brought into position during welding for safety reasons. The welding torch must be cleaned after welding.
TablePainting	A robot must paint the surface of a table with the help of a spray gun in the TablePainting.mod workcell. This painting sequence can also be simulated (see also chapter 5.5). As an initial exercise, you should first test the painting sequence in teach-in mode in order to gain a bit of experience with painting quality. The tool for automatic trajectory generation can also be used in order to calculate the robot's paths for execution of the painting sequence (see also chapter 4.3). The effects of the parameter settings must be determined in this case.

CarPainting

The goal of the CarPainting.mod workcell is to paint a car hood. Due to the fact that the hood is a freeform surface, it is very difficult to create a painting sequence without the help of automatic trajectory generation. Nevertheless, an attempt should be made to complete some of the calculations with the help of teach-in points, in order to gain a better understanding of the problem.

PCBMounting

The PCBMounting.mod workcell is highly demanding, and is well suited for project work. It simulates a PCB production line which consists of 6 work stations:

- Station for inserting ICs
- Station for soldering ICs
- Station with three robots which position the PCB holder
- Station for assembling the PCB to the holder
- Station for screwing the PCB to the holder

The individual robot programs must be created. Finally, master controls must be developed which coordinate the individual actions.

PlantSimulation

The PlantSimulation.mod workcell simulates an entire production facility that consists of several manufacturing cells:

- The **AGV** workcell includes an automated guided vehicle system (AGVS) that interconnects the individual manufacturing cells within the entire production facility. The AGVS receives picking orders which it fulfils autonomously. The workcell consists of the AGVS, a robot and various workpiece carrier trays with sensors.
- The **Workshop** workcell consists of two Mitsubishi robots, one of which is mounted to an additional linear axis. The robots must execute simple handling tasks in a work-order related fashion.
- The **Storage** workcell controls automated warehousing. It is linked to the AGVS by means of a conveyor belt.

- The **Production** workcell consists of a robot, an injection moulding machine, a press, a laser labelling unit and a conveyor belt which links it to the AGVS. A ventilator fan base is produced in this workcell.
- The ventilator fan base must be painted in the **Paintshop** workcell, which consists of a robot, a rotary table, a gripper changeover module for grippers with various paint spray guns for different colours, and a conveyor belt which links it to the AGVS.
- The individual parts of the ventilator are then assembled in the **Assembly** workcell. This workcell consists of two robots and a conveyor system.
- The ventilator is inspected and packaged in the **CheckPack** workcell. It consists of a robot, packaging materials and a conveyor belt which links it to the AGVS.

The individual workcells are available as separate cell models, so that each workcell can initially be processed alone. Integration can then be accomplished in the form of a large project.

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3. Working with COSIMIR®

After starting COSIMIR® Educational, you can directly access the COSIMIR® Assistant:

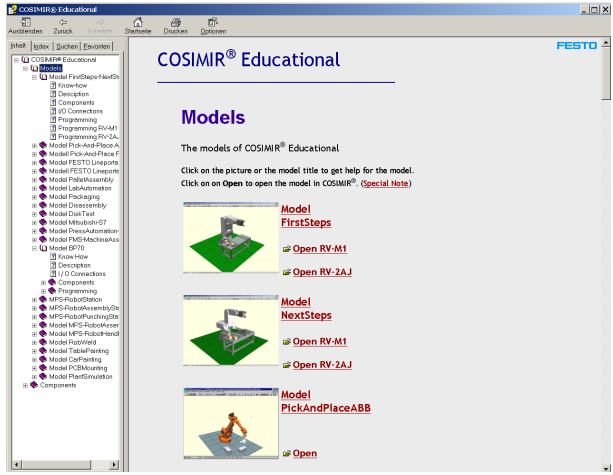


Figure 3.1: Graphic navigation in the library of workcells

3.1 COSIMIR® Help

The COSIMIR® help function is subdivided into three parts:

- Online help for working with COSIMIR®
- The COSIMIR® Robotics Assistant
- COSIMIR® Educational which provides a comprehensive library of predefined robotic workcells

The menu bar

The menu bar provides access to functions like those of a standard Internet browser. You can scroll forwards and backwards. You can display or hide the navigation bar. You can select a home page, as well as other options for Internet connections. You can print out any selected topics that serve your needs.

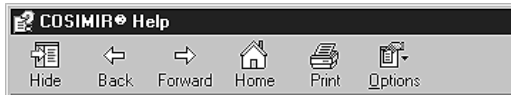


Figure 3.2: The menu bar

Additional index cards

You also have the option of conveniently navigating within the COSIMIR® help function using additional index cards including contents, index, search and favourites.

- The **Contents** index card displays the entire contents of the COSIMIR® help function in an explorer layout, which can be navigated just like the Microsoft explorer.
- The **Index** displays all of the keywords used by the entire help function, by means of which information can also be accessed.
- The **Search** function facilitates full-text retrieval using all of the terms that occur within the entire COSIMIR® help function.
- You can create your own explorer structure for the COSIMIR® help function with the **Favourites** index card.

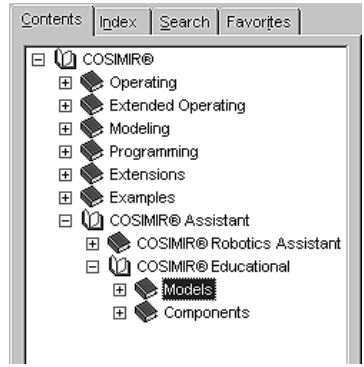


Figure 3.3: Help function index cards

3.2 The COSIMIR® Assistant

The COSIMIR® Assistant provides you with an online learning environment for robotics applications in the field of automation technology. The assistant is subdivided into two parts:

- The COSIMIR® Robotics Assistant
- COSIMIR® Educational

The educational part provides you with a description of all of the robotic workcells. All applications can be accessed directly via the graphic navigator (see also chapter 2.3).

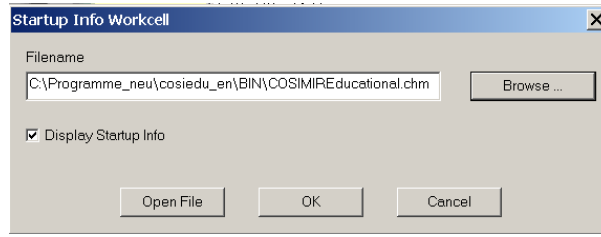


Figure 3.4: Start-up information dialogue box

The dialogue box is opened by clicking the **Start-up info** function in the **Help** menu. The graphic display of the robot model appears here under the directory path used during installation. You can activate or deactivate the display of this file each time COSIMIR® Educational is started. Acknowledge your setting with the **OK** button. You can also select another directory path by clicking the **Browse** button, and display it immediately using the **Open file** button, or select it as a start-up information file.

Now it's time to finally get started with a robotic workcell in COSIMIR®. You need only click the button shown in the screenshot on the left, and the corresponding workcell model is opened in COSIMIR®:

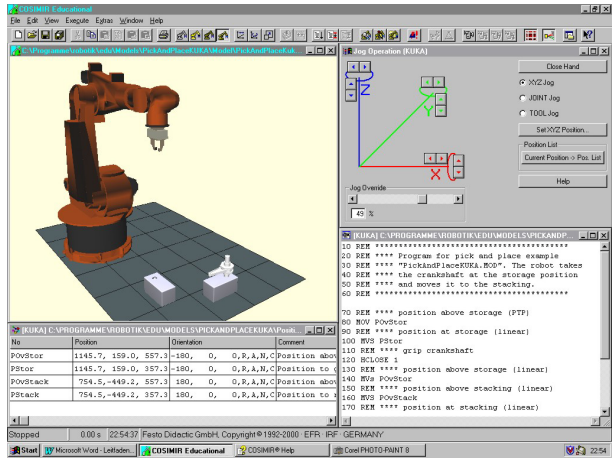
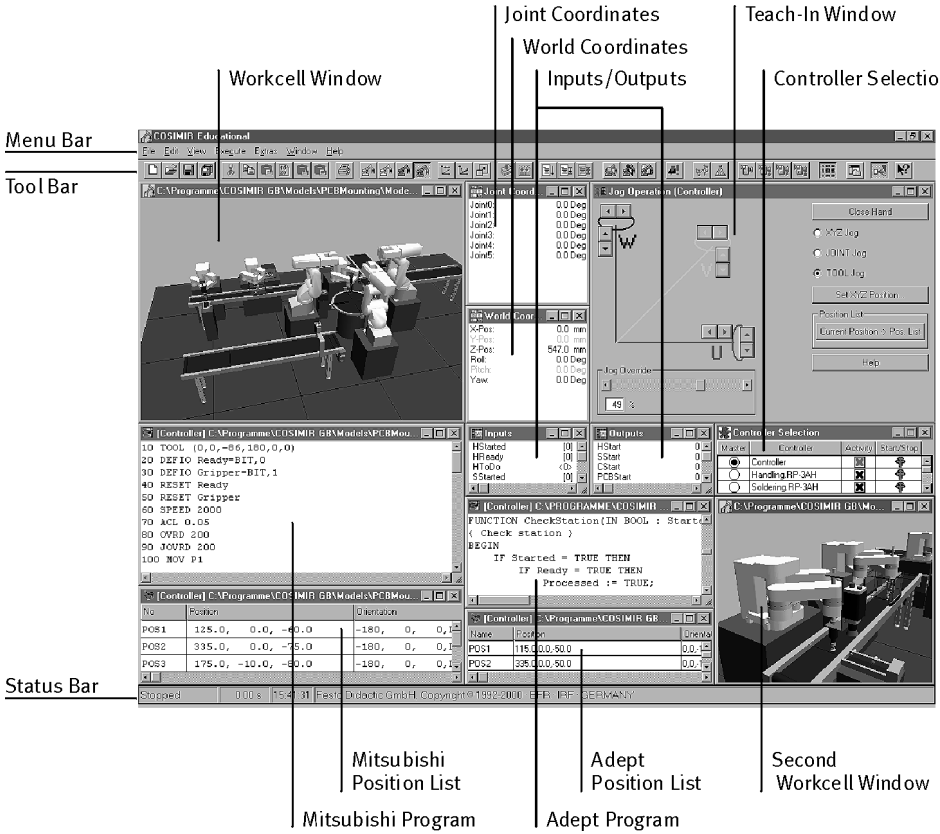

COSIMIR Educational
File Edit View Execute Extras Window Help
Jog Operation (KUKA)
Close Hand
XYZ Jog
JOINT Jog
TOOL Jog
Set XYZ Position...
Position List
Current Position -> Pos. List
Help
Jog Override
10 REM **********
20 REM **** Program for pick and place example
30 REM **** "PickandPlaceKUKA.MOD". The robot takes
40 REM **** the crankshaft at the storage position
50 REM **** and moves it to the stacking.
60 REM **********
70 REM **** position above storage (PTP)
80 MOV POvStor
90 REM **** position at storage (linear)
100 MVS PStor
110 REM **** grip crankshaft
120 RCLOSE 1
130 REM **** position above storage (linear)
140 MVS POvStor
150 REM **** position above stacking (linear)
160 MVS POvStack
170 REM **** position at stacking (linear)
No Position Orientation Comment
POvStor 1145.7, 159.0, 557.3 -180, 0, 0,R,A,N,C Position abov
PStor 1145.7, 159.0, 357.3 -180, 0, 0,R,A,N,C Position to
POvStack 754.5,-449.2, 557.3 180, 0, 0,R,A,N,C Position abov
PStack 754.5,-449.2, 357.3 180, 0, 0,R,A,N,C Position to
Stopped
Festo Didactic GmbH, Copyright © 1992-2000 EFR IRF GERMANY
Start
Microsoft Word - Leitfaden...
COSIMIR Educational
COSIMIR® Help
Corel PHOTO-PAINT 8
22:54

Figure 3.5: Work-cell in COSIMIR® Educational

The opened workcell includes a display of all of the windows that are required for solving the assigned problem. If you chose not to install the solutions during installation, the position list and the programming window are empty, but they are set up such that you can begin work.

The basic procedures for working with COSIMIR® are described in the following pages.

3.3 The COSIMIR® User Interface



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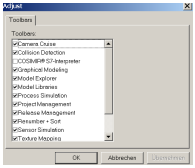
3.4 Window Types

The most important window types used in the COSIMIR® user interface are described below.



The Toolbar

Additional tools can be selected for inclusion in the toolbar with the menu function **Extras → Settings → Adjust**. We recommend the following tools in any case:

- Collision detection
- Model explorer
- Project management
- Renumber & sort

The Workcell Window

A graphic representation of the currently selected workcell is displayed in the workcell window. Additional views can be opened in the workcell window with the menu function **View → New**, allowing you to observe different perspectives simultaneously. The three dimensional representation of the workcell is dependent upon the selected point of view.

Click the button shown in the toolbar screenshot on the left (Ctrl + shift). The mouse pointer appears in the form of this button, and can then be used to enlarge or reduce the display by moving the mouse.

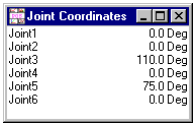
Click the button shown in the toolbar screenshot on the left (shift). The mouse pointer appears in the form of this button, and can then be used to move the display by moving the pointer along the coordinate axis.

The display can be rotated around the individual coordinate axes with the help of this button (Ctrl).

You can also select various predefined standard views. Use the menu function **View → Standard** to this end. A dialogue box appears which includes various options:

- Preset (O)
- Front view (V)
- Rear view (U)
- Top view (A)
- Left-hand side view (L)
- Right-hand side view (R)

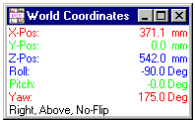
The desired view appears after clicking one of the above options, as long as the workcell window is open. This can also be accomplished by simply activating the corresponding keyboard keys.



Joint Coordinates

Press the **F7** key or select the menu function **Extras → Robot position → Show joint coordinates**.

The **Joint coordinates** window displays the individual positions of each of the robot's joints. Position is specified in degrees for rotary axes, and in millimetres for linear axes. The **Set joint coordinates** dialogue box can be accessed by double clicking this window.



World Coordinates

Activate the shift+F7 key combination or select the menu function **Extras → Robot position → Show world coordinates**.

The **World coordinates** window displays the position and orientation of the TCP (tool centre point) in world coordinates. In addition to position and orientation, the robot's configuration appears in the bottommost line in the window. The **Set world coordinates** dialogue box can be accessed by double clicking this window:

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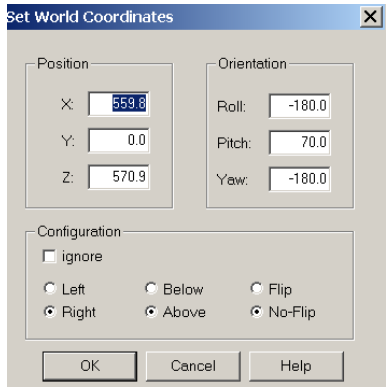
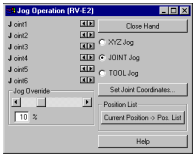




Teach-In

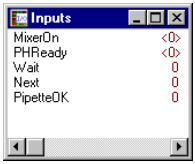
Activate the F8 key or select the menu function **Extras → Teach-in**. In addition to the designations of the robot's joints, the window that now appears includes two small buttons which can be used to advance the robot's individual joints. The performance of a real robot is simulated when these buttons are activated. The robot is accelerated to the preset speed (override) if one of these buttons is pressed and held. The preset speed is then held constant, and braking to a speed of 0 ensues when the button is released, controlled by means of a acceleration ramp.
By clicking the corresponding option, teach-in can be performed using world coordinates or tool coordinates.
Further details are included in chapter 4.1.

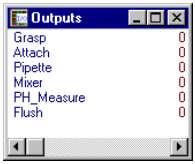
Display Coordinate Systems

Various types of coordinates systems can be displayed for support.

Select the menu **Extras → Coordinate systems** to this end (**Ctrl + K**):

- Show tool centre point (The path of the TCP is recorded when this option is selected.)
- Show world coordinate system (coordinate axes are displayed in colour)
- Show basic coordinate system (robot coordinate system)
- Show object coordinate system
- Show gripping points

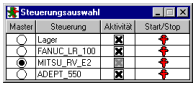




Inputs/Outputs

Press the F9 key, activate the Ctrl+F9 key combination or select the menu function **Extras → Inputs/outputs → Show inputs** or **Show outputs**.

The **Inputs** window shows which signals are being applied to the inputs of the simulated controller. 0 signals are displayed in red, and 1 signals in green. If the input signal is forced, this is indicated by the fact that the input value appears in angle brackets, e.g. <1>. If the input is linked to an output, the input value appears in brackets, e.g. [1]. the same applies to output displays.



Controller Selection

Select the menu function **Execute → Controller selection**. COSIMIR® Educational includes workcells with several controllers, for example one PLC and two robot controllers, which work together simultaneously in the simulation mode. However, if a procedure is to be taught into a robot, the teach panel must be first allocated to the desired robot. This task is executed by the controller selection window. It is used to display and select a master, and to activate and/or deactivate individual controllers. The display of robot positions, the display of inputs and outputs, and teach-in are only possible for the robot that has been selected as a master.

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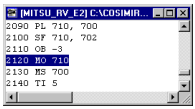
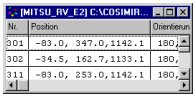


Robot Program

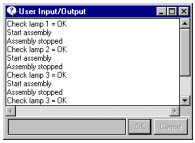
Click the menu function **File → Open** and select the desired file type, i.e. *.MB4 (Melfa Basic IV), *.MRL (Movemaster Command) or *.IRL (industrial robot language). Or create a new program with the menu function **File → New** and select the desired window type, i.e. IRL program, Movemaster Command program or MELFA BASIC IV program.
The screenshot shown on the left contains a robot program in high-level language using the native language of the respective robot. The name of the associated object is specified in the header.



Position List

Click the menu function **File → Open** and select the desired file type, i.e. *.POS (for Mitsubishi robot) or *.PSL (for industrial robot language). Alternatively, create a new position list with the menu function **File → New** and select the desired window type, i.e. MRL position list (Mitsubishi robot) or position list.
The screenshot shown on the left contains a position list for a robot. The name of the associated object is specified in the header.

The **New** function in the **File** menu can also be accessed with the button shown in the screenshot on the left, or with the Ctrl + N key combination.



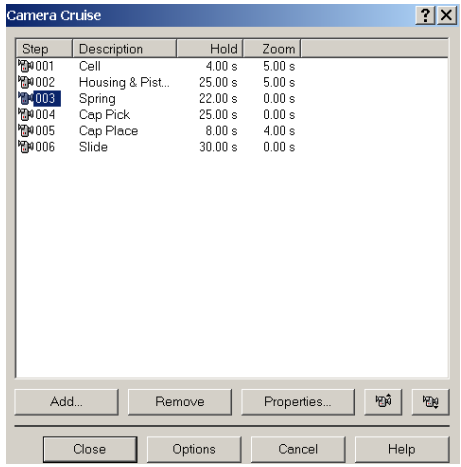
User Input/Output

The **User Input/Output** window appears automatically if the robot program contains commands with which data can be read in or read out, for example via the serial interface at the robot controller.
Due to the fact that the robot controller is only replicated in the simulation, data are not transmitted via the serial interface, but rather via the **User Input/Output** window.

Camera Cruise

Camera cruise can be activated or deactivated with the menu function **Execute → Camera cruise**. The first toolbar button shown in the screenshot on the left can be used to access this function as well. When a simulation is started, movement is initialised to the stored points of view, one after the other. Linear interpolation is utilised between the views, assuring smooth motion from one to the next.

After clicking the menu function **Extras → Settings → Camera cruise**, a dialogue box appears which allows you to store various views of your workcell window:



Select the desired point of view for your workcell window and click the **Add** button, in order to add the current view to the list. Existing views can also be removed from the list. If you want to change the settings for a view, select the respective view and click the **Properties** button:

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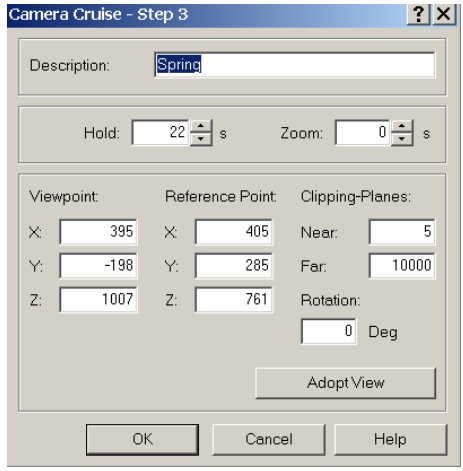


You can name the selected view, assign a dwell time and a zoom time, and change the point of view manually.

Creating an Animation

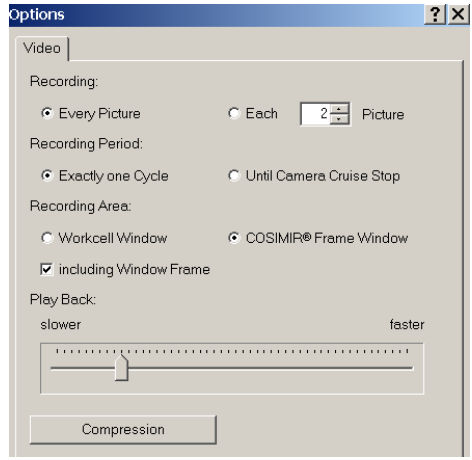
You can create an animation of your simulation with the help of the camera cruise function. The animation is saved as an AVI file. Trainees can use this file for their own presentation purposes, or can submit it as the result of their project.

To create an animation of your simulation:

1. Configure a camera cruise sequence and test it in combination with your simulation.
2. In order to create an animation, start simulation and recording of the camera cruise sequence with the second toolbar button shown in the screenshot on the left.

3. Recording is stopped by clicking the last toolbar button shown in the screenshot on the left.
4. The animation can then be played back with the third button and stopped with the last button.

It is advisable to configure the recording after completion, in order to optimise the animation file:



Details regarding configuration are included in the COSIMIR® help function under **Advanced → Camera cruise → Configuring camera cruise → Settings dialogue box – Video**. Further helpful support is provided by the **Camera cruise** video in the COSIMIR® help function under **Examples → Operating**.

4. Programming

The following programming languages can be used in COSIMIR® Educational for programming robots:

- Mitsubishi MELFA Basic IV robot programming language
- Mitsubishi MRL robot programming language
- Standardised industrial robot language (IRL DIN 66312)

We have proceeded as follows in creating sample programs for the models:
All Mitsubishi robots have been programmed using MELFA Basic IV, as long as this language is supported by the respective controller. MRL has been used for all other Mitsubishi robots. Other types of robots have been programmed using IRL.

The “Robot Programming” section of the Robotics Assistant includes comprehensive information regarding the programming of robots. Details regarding the programming languages are contained in the chapter entitled “Programming Languages” in the COSIMIR® help function.

4.1 Teach-In

In order to create a robot program, certain positions must be defined to which the robot travels under certain conditions. Generally speaking, a robot can be advanced with the help of a manually operated control panel in order to teach such positions. COSIMIR® provides users with two different methods for advancing the robot manually:

- With the mouse
- In the teach-In window

Click in close proximity to the gripper end point with the left mouse key. A voxel (pixel in 3D space) is marked at the clicked point. If you double click the voxel, the robot moves to the selected point, if it lies within its working range. The robot can be advanced in a much more targeted way with the universal teach panel. The teach panel can be accessed via the **Teach-in** function in the **Extras** menu (**F8**).

Select the “Joint coordinates” mode from the teach-in window.

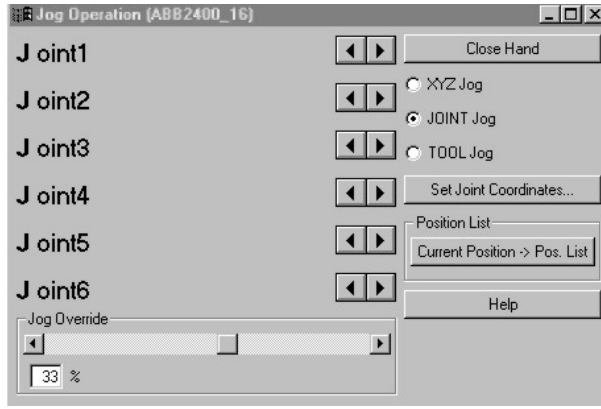


Figure 4.1: Teach panel with joint coordinates

Select one of the robots six joints and click one of the corresponding arrow buttons: The robot moves around the selected joint in the corresponding direction. Speed can be selected with the override slider.

After clicking the **Set Joint coordinates** button, a dialogue box appears to which joint coordinate values can be explicitly entered.

The robot's current position can be transferred to the respective position list by clicking the **Current Position → Pos. List** button.

The gripper can be closed by clicking the **Close gripper** button, after which the button is renamed as **Open gripper**.

Select the "World coordinates" mode in the teach-in window in order to move the robot within the Cartesian coordinate system:

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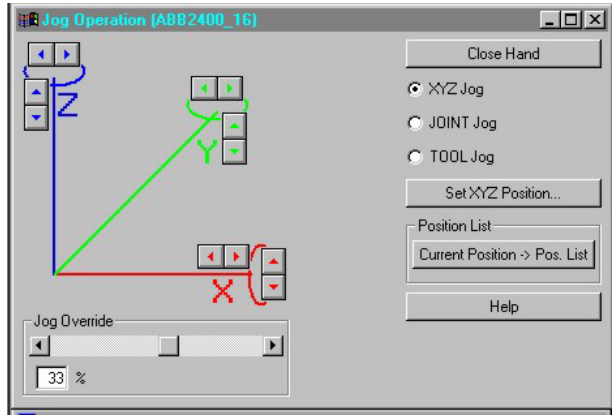

Figure 4.2: Teach panel with world coordinates

The robot can be moved along the world coordinate axes, and the gripper can be rotated around these axes by clicking the corresponding arrow buttons. Further details are included in the COSIMIR® help function under **Operating → How to ... → How to move and position the robot in COSIMIR**.

Select the “Tool coordinates” mode in the teach-in window in order to move the robot within the tool coordinate system. The tool coordinate system is the robot’s basic coordinate system, but the zero point has been shifted to the robot’s TCP.

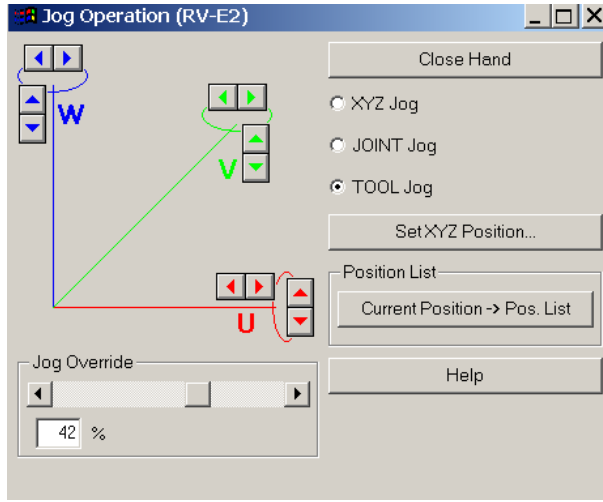

Figure 4.3: Teach panel with tool coordinates

As described above, the robot can be moved along the tool coordinate axes and the gripper can be rotated around these axes by clicking the corresponding arrow buttons. Note that the TCP remains unchanged. How can this be double checked?

4.2 Example: Programming a Workcell

This example necessitates the creation of a program for the Mitsubishi RV-2AJ robot that solves the sample task posed in section 2.3 for the First Steps workcell.

Open the First Steps RV-2AJ workcell with the help of the graphic navigator, or open the FirstSteps RV-2AJ.mod file (directory path: ...\Models\FirstSteps\Model) with the menu function **File → Open**.

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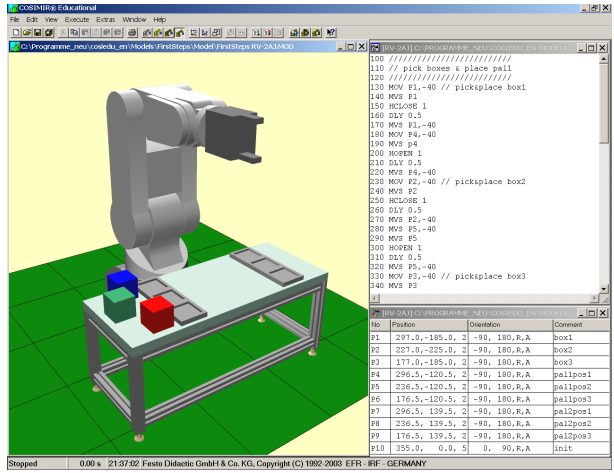
COSIMIR® Educational
File Edit View Execute Extras Window Help
C:\Programme_neu\cosedu_en\Models\FirstSteps\Model\FirstSteps RV-2AJ.MOD
100 ////////////////////////
110 // pick boxes & place pal1
120 ////////////////////////
130 MOV P1,-40 // pick&place box1
140 MVS P1
150 HCLOSE 1
160 DLY 0.5
170 MVS P1,-40
180 MOV P4,-40
190 MVS P4
200 HOPEN 1
210 DLY 0.5
220 MVS P4,-40
230 MOV P2,-40 // pick&place box2
240 MVS P2
250 HCLOSE 1
260 DLY 0.5
270 MVS P2,-40
280 MVS P5,-40
290 MVS P5
300 HOPEN 1
310 DLY 0.5
320 MVS P5,-40
330 MOV P3,-40 // pick&place box3
340 MVS P3
No Position Orientation Comment
P1 297.0,-185.0, 2 -90, 180,R,A box1
P2 227.0,-225.0, 2 -90, 180,R,A box2
P3 177.0,-185.0, 2 -90, 180,R,A box3
P4 296.5,-120.5, 2 -90, 180,R,A pal1pos1
P5 236.5,-120.5, 2 -90, 180,R,A pal1pos2
P6 176.5,-120.5, 2 -90, 180,R,A pal1pos3
P7 296.5, 139.5, 2 -90, 180,R,A pal2pos1
P8 236.5, 139.5, 2 -90, 180,R,A pal2pos2
P9 176.5, 139.5, 2 -90, 180,R,A pal2pos3
P10 355.0, 0.0, 5 0, 90,R,A init
Stopped
0.00 s 21:37:02 Festo Didactic GmbH & Co. KG, Copyright (C) 1992-2003 EFR - IRF - GERMANY

Figure 4.4: FirstSteps RV-2AJ.mod

Sample task

As a reminder, the blue workpiece must first be set onto the middle section of the first pallet. After a waiting period of 2 seconds, it must then be sorted into the bottom section of the second pallet.

Creating a position list

We've already created the sequence plan in chapter 2.3. Now we'll need to create a position list. First, delete the contents of the predefined MRL position list and save it under the following new name: "FirstStepsTest.pos".

- Add the robot's initial position as the first entry to the position list. Click the **Current Position → Pos. List** button in the teach-in window to this end.
- The second position (P2) is the gripping position for the blue workpiece. A line in the position list is highlighted after clicking underneath the first position. Click the **Current Position → Pos. List** button in the teach-in window once again. As an exercise, position P2 will be edited manually. Select position entry P2 to this end.

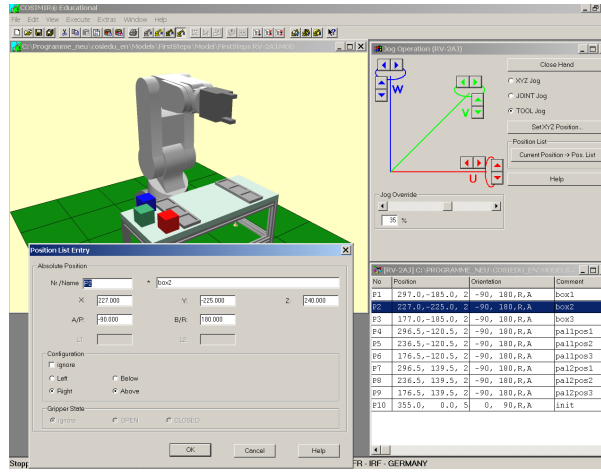

Figure 4.5: Position list entry

- The **Position list entry** dialogue box can be accessed with the menu function **Edit → Properties** (Alt+Enter). Edit the displayed position data as follows:
  – Positions (X, Y, Z) = (167.00, -185.00, 240.00)
  – Orientation (roll = A/P, pitch= B/R) = (-90.0, 180.0)
- Move the robot to the new P2 position by double clicking the position list entry.
- Close the gripper by clicking the **Close gripper** button in the teach-in window.
- Use the world coordinate system in order to position the robot such that the blue workpiece is set into the middle section of the first pallet.

Tip

The coordinate axes can be displayed for improved orientation: **Extras → Coordinate systems → Show world coordinate system**

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Gripper settings

The gripper settings dialogue box can be opened with the menu function **Extras → Settings → Gripper**.

Figure 4.6: Gripper settings

All outputs are included in the **Teach-in gripper control** drop-down list, which are assigned to objects capable of executing gripping tasks. This output is activated whenever you click the **Close gripper** button in the teach-in window. You can also choose to have possible warnings displayed for gripper operations.

Three dimensional navigation

It is helpful to open a second workcell window to facilitate three dimensional navigation (see also 3.4).

- After moving to the desired position has been successfully completed, add this position to the position list as point P3.
- P4 is the final position in the second pallet.

Video (help function)

Videos entitled “Teach-In”, “Position list” and “Working with Positions” are included in the COSIMIR® help function under **Examples → Operating**, which address the subjects of robot teach-in procedures and working with the position list in the simulation.

Creating the program

Click into the programming window in order to activate it. Delete its contents and save it as a Melfa Basic IV program under the name of the position list: “FirstStepsTest.mb4”. The names of the program and the associated position list must be identical!!!

The MELFA Basic IV programming language is a dialect of Basic, and each program line must thus be numbered. However, numbering has been automated. First create the program lines without any numbering. Now click the button shown in the toolbar screenshot on the left (**Extras → Settings → Renumber**).

Implement the sequence plan from chapter 2.3 step by step in order to create the program.

Sequence Plan	
The robot’s gripper is open.	**10 HOPEN 1**
The robot moves the gripper to the gripping position with a PTP movement.	**20 MOV P2**
The gripper is closed.	**30 HCLOSE 1**
The robot moves the gripper to the intermediate position with a PTP movement.	**40 MOV P3**
The gripper is opened.	**50 HOPEN 1**
The robot executes linear travel back to a point above the intermediate position.	**60 MVS P3,-40**
2 second waiting period	**70 DLY 2**
The robot moves the gripper to the intermediate position (linear travel).	**80 MVS P3**
The gripper is closed.	**90 HCLOSE 1** **100 MOV P4,-40** **110 MVS P4** **120 HOPEN 1** **130 MOV P1** **140 END**

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Note

Add an empty line at the end of the program!

For assistance during programming, execute a right click inside the programming window. You are then provided with a list of the most important function calls, and the corresponding function commands are edited in the programming window via mouse click.
Comprehensive, structured documentation of all Melfa Basic IV programming commands can be accessed in the Robotics Assistant under **Programming robots → Robot programs → Basic course**. Save your program after it has been completed.

Melfa Basic IV Project

Before compiling your program for the first time, you'll have to create a project. The project includes all of the associated programs and their respective position lists. Select the **Project management** function in the **Execute** menu, or click the
button shown in the toolbar screenshot on the left.

The following project management configuration window appears:

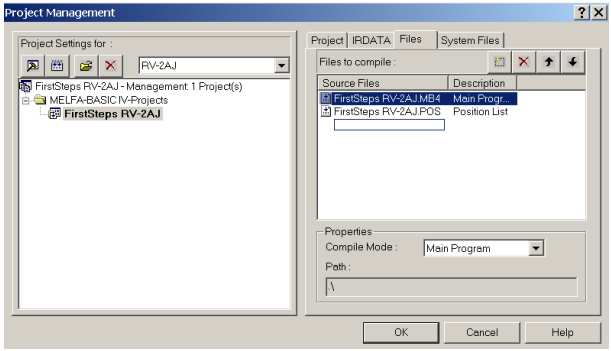

Figure 4.7: Project management

In order to create a new project, select the **MELFA-BASIC IV projects** entry and click **Add project** in the context menu.

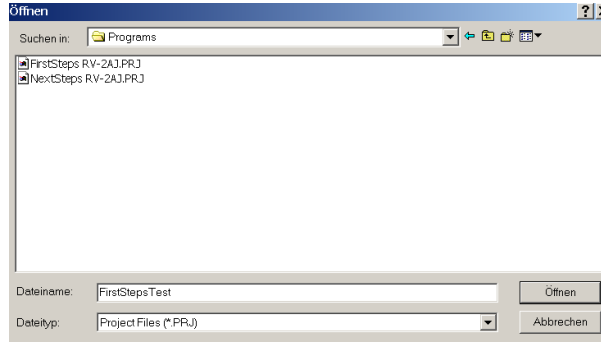

Figure 4.8: Project entry

Enter a project name and acknowledge your entry with the **Open** button.

Select the **Files** register card and click the button shown in the screenshot on the left. You are then prompted to open the program file. The project name then appears in the right hand portion of the project management window. Click the empty entry at the bottom, and the corresponding line is selected. Now add the associated position list by selecting the “MELFA BASIC IV position list (*.POS)” file type in the file selection window.

Due to the fact that a multitasking system is utilised, you’ll have to establish which program is the main program. In this example, your program is of course the main program. Select your program entry in the project management window to this end, and select **Main program** from the **Compiler mode properties** drop-down list.

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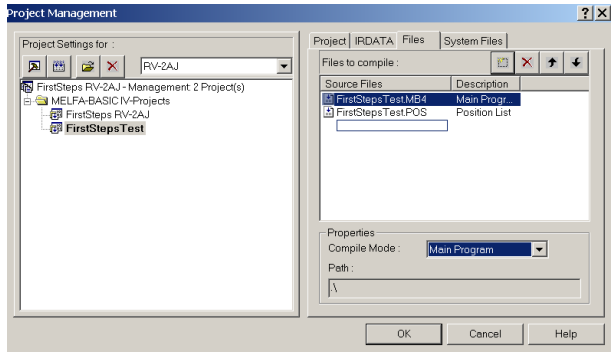

Figure 4.9: Creating a new project

Now, activate your project. Select your project entry and click **Set as Active Project** in the context menu. Acknowledge your project entry by clicking the **OK** button.

You can now download your project to the internal robot controller. Activate the program window and click the **Compile & link** function in the **Execute** menu (Ctrl+F9), or click the button shown in the screenshot on the left.

Utilised program and system modules, as well as the number of errors and warnings, appear in the **Messages** window.

If error messages appear, the corresponding program line can be highlighted in the program window by double clicking the respective error message.

Caution!

As a result of cause and effect, it is entirely possible that a different line will be highlighted which appears underneath the actually faulty program line.

If program syntax is error-free, you can start analysing the program sequence with the help of the simulation function.

4.3 Automatic Path Generation

This advanced COSIMIR® function for automatic, surface oriented trajectory generation provides programmers of robots used for coating and deburring tasks with support by automatically generating robot paths, and the corresponding robot programs. Time involved in offline robot programming can thus be minimised, and process results can be optimised at the same time.

A table must be painted by a robot in the “Table Painting” sample workcell. You can create the required trajectories by means of suitable teach-in positions, or you can use the trajectory generating tool. In this example, “Table” must be selected from the object folder in the model explorer (see also 6.3), after which trajectory generation is started with the menu function **Execute Surface → trajectories**.

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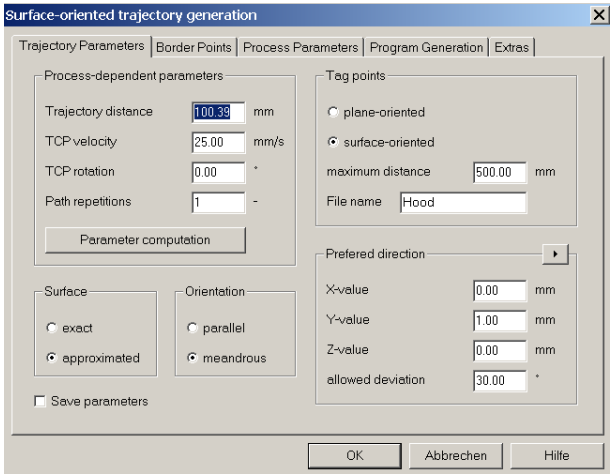

Figure 4.10: Surface trajectory generation

The dialogue box shown above is opened before automatic generation of the paths' intermediate positions. Additional parameters can be entered here, in order to optimise the generating process.

A comprehensive representation of this method is included in the COSIMIR® help function under **Extensions → Surface oriented trajectory generation**. In addition to this, a video dealing with actual use of this method can be found under **Examples → Operating**.

4.4 Download to the Mitsubishi Robot Controller

All of the programs you create in the Movemaster Command or MELFA Basic IV languages can be downloaded to a Mitsubishi controller via COSIMIR® Industrial or COSIMIR® Professional. Open a new project in COSIMIR® to this end with the **New project** function in the **File** menu, select the appropriate robot and set up the communications link. Open your program and your position list, and resave the files to COSIMIR® Industrial or COSIMIR® Professional! Establish communication with the robot and download the robot program and the position list.

Caution!

Execute the following tests before starting the program after it has been successfully downloaded:

- Are all teach-in points correct?
- Have all inputs and outputs been correctly wired?
- Has the TCP been set correctly?

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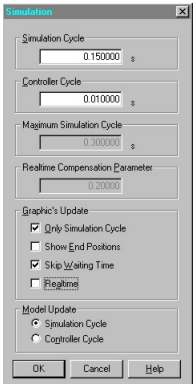
5. Simulation

The simulation of programs that have been written offline using COSIMIR® is described in the following pages.

5.1 Settings



Use the menu function **Execute → Simulation** for configuration.

Simulation
The simulation rate determines how frequently the graphic representation is refreshed. The motion display becomes smoother, but also slower, as the selected value for the simulation rate is reduced. The control rate is used to calculate intermediate positions for robot controllers, and serves as a cycle time for stored program controllers. The control rate determines the various possible simulation rate settings.
If you have selected the **Real-time** option, the simulation rate is adjusted automatically. In the event of inadequate PC performance characteristics, a real-time link may not be possible, resulting in a continuous increase of the simulation rate. This effect can be limited by specifying a **Maximum simulation rate**. The **Control parameters** option is only available if the **Real-time** checkbox has been activated. This parameter establishes which constant is utilised to control the relationship between simulation time and real-time.

5.2 Example: Workcell Simulation

Open the **First Steps RV-2AJ** workcell with the **First Steps Test** project from the proceeding chapter. Start the simulation with the **Start** function in the **Execute** menu, or click the button shown in the toolbar screenshot on the left. The program is simulated step by step. Simulation time is displayed in the **Status line**. The program line that is currently being simulated is highlighted in the program window. At first, you can execute each program step individually with the help of the button shown in the toolbar screenshot on the left.

If you want to start a new simulation cycle, it is advisable to return the robotic workcell to its initial position. Use the menu function **Edit → Reset Workcell** to this end.

Simulation serves to check your program for two important criteria:

- Is the functional sequence correct?
- Can run time be further optimised?

We'll concentrate here on the first question, i.e.

- Is the logical sequence correct?
- Are there any collisions?

You should be able to answer the first question on your own.

Collision detection

As regards collision detection, you should first decide which components are to be examined for possible collisions.

Example

Consider our sample program to this end. The first critical point is certainly the transfer of the blue workpiece to the first pallet. The task in this case is to specify that these two objects will be examined for possible collision.

Use the menu function **Extras → Settings → Collision detection** to this end. Click the **Selection** index card

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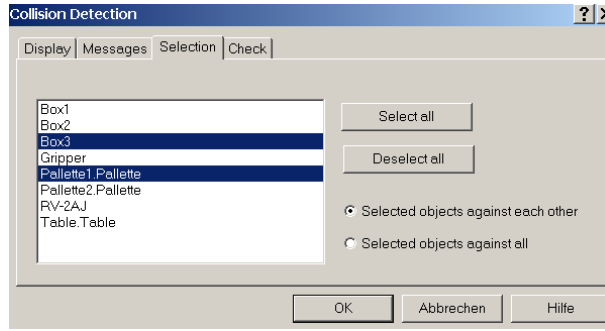

Figure 5.1: Object selection for collision detection

The index card displays a list of all of the objects included in the workcell. Box3 is the blue workpiece. Select Box3 and Pallet1.Pallet as you would in the Windows explorer. Select the **Selected objects against each other** option, in order to determine whether or not the selected objects collide with each other.

Click the button shown in the toolbar screenshot on the left in order to activate collision detection, or select the **Collision detection** function in the **Execute** menu. Start the simulation once again. Notice that the blue workpiece turns red during transfer before it is set down onto the first pallet. This indicates that a collision has occurred. This collision persists, because the workpiece is set down onto the pallet. How can we eliminate this collision before the workpiece is set down?

Recommended solution: Replace line 40 with the following:
40 MVS P2,-30
41 MOV P3,-30
42 MVS P3

For a more detailed visualisation of collision detection use your sample program in the slightly modified NextSteps RV-2AJ.mod workcell, and test for collisions with the glass plate.

Video (help function)

A video that demonstrates how to set up the collision detection function is included in the COSIMIR® help function under **Examples → Operating**.

5.3 Sensor Simulation

The sensor simulation functions expand the capabilities of COSIMIR® such that complete robotic workcells can be simulated. Many of the sensors utilised in manufacturing automation can be realistically configured and simulated. Visualisation of sensor measuring ranges, which is not possible in real applications, provides additional help in avoiding design errors during the planning stages. Sensors are utilised in numerous workcells, for example in the MPS® Robot Station, for detecting objects and materials. The characteristics of these sensors can be analysed with the model explorer (see also chapter 6.3).

5.4 PLC simulation

The COSIMIR® S7 simulator interprets executable S7 programs. Each workcell may include several stored program controllers. Each PLC is controlled by an S7 program. It is not possible to change the S7 program furnished with COSIMIR® Educational.

An overview of the S7 controllers and the installed S7 programs can be accessed with the **S7 Program Manager** function in the **Execute** menu. Presented in a clear-cut tree structure, the S7 program administration window displays the name and elucidates the structure of the PLC programs that have been installed to each of the controllers within the selected workcell. Programs may consist of the following elements:

- Organisational modules
- Function modules
- Data modules
- Functions
- System functions

The contents of each type of element can be displayed by double clicking the respective element.

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Your S7 programs can be displayed in the STL programming language. All modules, organisational modules, function modules and functions are displayed in tabular form. Modules that cannot be represented in STL syntax are excluded, for example system functions and system function modules.

Further details are included in the COSIMIR® help function under **Programming → S7 simulator**.

5.5 Process Simulation

Process simulations for coating and deburring operations make it possible for robotics programmers to optimise the manufacturing sequence at an early stage during program creation and, at the same time, qualitatively evaluate processing results. This eliminates the necessity for time consuming testing of motion sequences with test objects, and the expense of offline programming is minimised while improving process results.

Process simulation is used, for example, in the Table Painting sample workcell. In order to activate process simulation, select the desired object from the model explorer (see also chapter 6.3), and start simulation with the **Process simulation** function in the **Execute** menu.

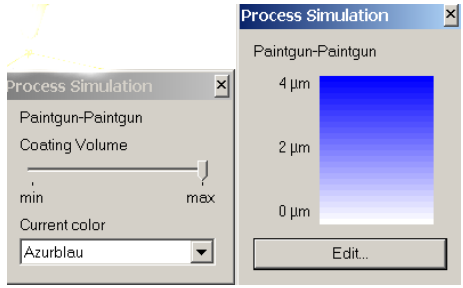

Figure 5.2: Process simulation settings

You are provided with the opportunity of configuring additional parameters for simulating the painting process.

The program can then be started, and you can observe the painting process at the same time.

Video (help function)

A video entitled “Process Simulation” is included in the COSIMIR® help function under **Examples → Operating**, which provides you with application support.

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6. Modelling

Although new workcells cannot be saved to COSIMIR® Educational, you are provided with numerous modelling functions within the workcells that allow you to change layouts, and to analyse alternatively configured problems.

Various tools are made available by COSIMIR® for modelling robot controlled workcells, for example model libraries and the model explorer. We'll help you get acquainted with the modelling function using the example provided in the chapter on programming.

6.1 Model Hierarchy

The following types of elements are included in the COSIMIR® model hierarchy:

Objects
Objects are at the top of the model hierarchy.
- Example: A robot is an object.

Groups
Groups are assigned to objects. Each group may enjoy a given degree of freedom, and can thus be moved relative to the previous group.
- Example: A robot joint is a group.

Components
Components are assigned to groups and determine the graphic representation.
- Example: Surfaces, cuboids and polyhedrons are components.

Gripper Points
A gripper point is assigned to a group included in the gripping object, so that one object can grip another.

- Example: A gripper point is located on the flange of a robot's sixth axis.

Gripping Points
A gripping point is assigned to a group included in the object to be gripped, so that one object can be gripped by another.

- Example: A workpiece that is gripped has a gripping point.

6.2 Model Libraries

COSIMIR® includes comprehensive model libraries, some of which are optional. Objects or model components can be added to a workcell from these libraries.

Click the menu function **Execute → Model Libraries**, or the button shown in the toolbar screenshot on the left.

The following model libraries are available:

- ABB robots
- Fanuc robots
- KUKA robots
- Mitsubishi robots
- Reis robots
- Stäubli robots
- Siemens S5/S7 SPC
- Various grippers
- Various basic forms
- Various LEDs
- Various materials
- Various mechanisms
- Various robots
- Various sensors
- Various controllers
- Various textures

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6.3 The Model Explorer

All of the elements included in a workcell can be accessed via the model explorer. In addition to objects and their subordinate elements, this also applies to materials, libraries, illumination settings and all I/O connections.

The model explorer is opened by clicking the menu function **Execute → Model Explorer** (Ctrl+T), or the button shown in the toolbar screenshot on the left.

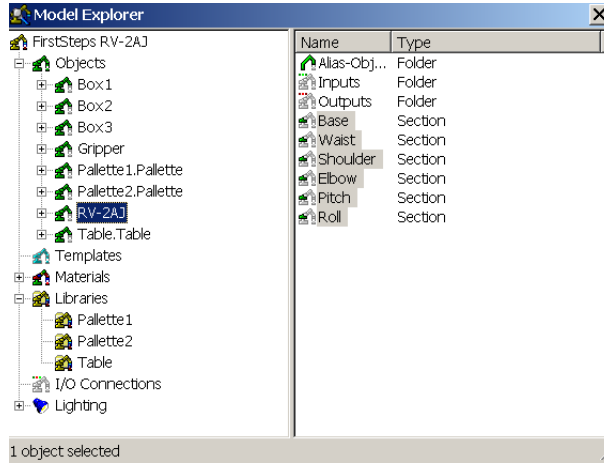

Figure 6.1: Model Explorer

The model explorer window is subdivided into two sections:
A tree structure used for navigation appears in the left-hand section including folders for the individual workcell elements.
The element list included in the right-hand side of the window displays the elements included in the folder that has been selected in the tree structure. Elements can be accessed by clicking the desired element in the tree structure (if it appears there), or in the element list.

An element selection context menu containing the most important commands can be displayed by double clicking an element or an element folder.

The **Objects** folder contains all of the workcells components. We make reference to this folder name in the workcells function descriptions.

Example

You want to determine the exact position of the green workpiece in the First Steps workcell expressed in world coordinates.

Solution

1. Activate the editing mode using the **Edit mode** function in the **Execute** menu (**Ctrl + E**), and open the model explorer. Click the green workpiece. The object is then selected and the associated object coordinate system is displayed. The “Objects” file is selected in the tree structure, as well as the appropriate component, i.e. “Box2”, in the display window. The desired allocation has now been established.
2. Click the “Box2” object in the tree structure and select **Properties** from the context menu. The **Object properties** dialog box appears, from which the **Position** index card must now be selected.

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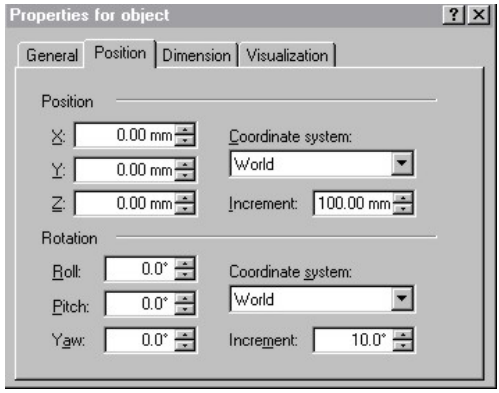

Figure 6.2: Object properties

The Cartesian coordinates of the zero point from the object coordinate system are displayed here, as well as the orientation of the object relative to the world coordinate system (roll: rotation around the Z-axis, pitch: rotation around the Y-axis, yaw: rotation around the X-axis).

Changing object properties

We want to expand our sample task by requiring that the cell is changed such that the green workpiece is approximately at the centre of the table, turned 45° relative to the world coordinate system:

Solution

1. The display of Cartesian coordinates and orientation values in the Object properties dialogue box can be directly overwritten, or you can change the displayed values using the arrow buttons in steps according to the selected increment. The workpiece is immediately moved to its new position.
2. Change the Y coordinate and the roll angle accordingly.

Note

The **Object properties** dialogue box includes additional parameters that are contained in the **General, Dimension, Visualisation** index cards etc. Except for display colour, it is not possible to change these additional object properties with COSIMIR® Educational.

Library elements

Objects in a workcell can also be grouped together as library elements. The goal is to assure that the included objects are always arranged in a fixed geometric constellation in relation to one another. Library elements are recognised by means of their designation. Library elements always have two-part names:
Library_name.Object_name
Example: (First Steps workcell): Pallet1.Pallet

Only the properties of the corresponding library element can be changed. For example, if you want to change the position of the first pallet, you must click the "Pallet1" object in the **Library folder** included in the tree structure, and open the **Properties** dialogue box from the context menu.

Video (help function)

A video entitled "Working with Objects" is included in the COSIMIR® help function under **Examples → Operating**, which explains how to work with objects in the model explorer.

I/O connections

After clicking **I/O connections** in the tree structure, an overview of all input-output assignments is displayed, and the designation of the associated object is shown for each input and output.

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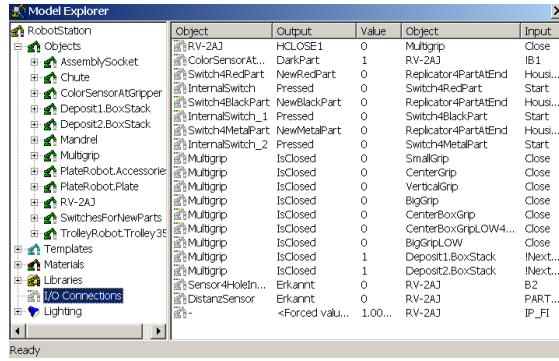
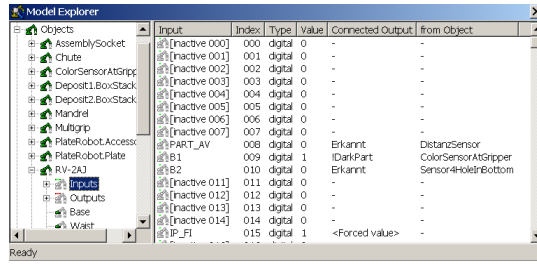


Figure 6.3: List of I/O connections

This overview is also included in the documentation for the workcell. You would also like to know which input bit is allocated to the symbolic “Part_AV” input at the robot controller in the “MPS® RobotStation.mod” workcell.

Solution

Open the folder for the RV-2AJ object and select the inputs subfolder. All input bits are then displayed in the right-hand window.



You can now see that the input in question is allocated to input bit no. 8.

6.4 Example: Modelling in a Workcell

In chapter 6.3 you learned how to change object properties, enabling you to easily modify the workcell layout.

There are numerous other possibilities of remodelling your workcell in a sensible fashion in COSIMIR® Educational.

Illumination

You wish to change the illumination in the graphic representation. Illumination consists of ambient light and up to 7 additional light sources. Open the **Illumination** folder and select the "Ambient light" object. Open the properties dialogue box from the context menu. The intensity and colour of the light can be changed.

You wish to find out which light sources are turned on in the sample workcell, and what effect they have on the workcell.
Select, for example, light source 1 with a left click. The orientation of the light source is graphically represented in the workcell window by means of a light beam, and the associated object properties window is opened. Light sources can be turned on and off, and their orientation, intensity and colour can be changed.

Robot selection

You want to replace the robot in a given workcell with a different robot, for example you would like to replace the RV-2AJ robot in the MPS® Robot Station with the 6-axis Mitsubishi RV-1A robot. Open the model explorer and select the name of the respective workcell, "RobotStation". Open the properties dialogue box via the context menu and select the libraries index card:

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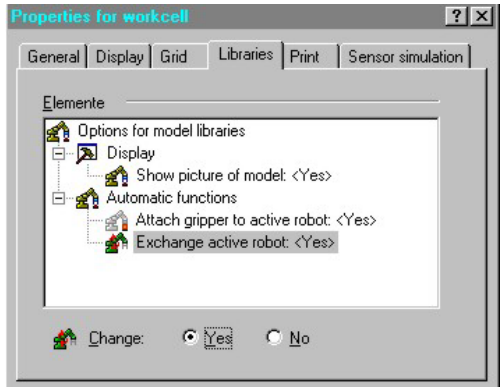

Figure 6.4: Work-cell properties

Select the “Exchange active robot” option. A line appears at the bottom prompting you to acknowledge the change. Select “Yes” and then close the dialogue box. Now open the model library dialogue box and select the RV-1A from the Mitsubishi robots folder. Add this robot to the process model. A dialogue box appears indicating that the operation cannot be undone. Acknowledge with “Yes”. The old robot is now replaced with the new one, and all I/O connections are updated as well.

Note

The name of the robot listed in the model explorer remains unchanged (RV-2AJ)! Don’t forget that all teach-in points must be updated.

Importing new components

Task

You want to set up a partition between the two pallets in the First Steps workcell, in order to demonstrate a collision problem.

Solution

The model library does not include a partition, but the Next Steps workcell does. Open the Next Steps workcell with **COSIMIR® Industrial or COSIMIR® Professional** and select the “Wall” component in the model explorer from the workcell’s object folder. Save the object as **wall.mod** via the context menu. This file can now be imported to any workcell in COSIMIR® Educational with the help of the menu function **File → Import**.

Gripping point

Create a rectangular workpiece with a side length of 45 mm in **COSIMIR® Industrial or COSIMIR® Professional**. Open the First Steps workcell in COSIMIR® Educational and import the new component named “Box4”. Position the component at the centre of the table. Teach the robot to grasp the new workpiece. What happens? Select the menu function **Extras → Settings → Grip** for troubleshooting assistance. Then select the “Gripper warnings” option in the configuration window.

A warning now appears when the gripper is closed: “No object”. Why does this warning appear?

Solution

Compare the structure of the Box3 and Box4 workpieces in the model explorer. As you can see, Box4 does not have a gripping point, which means that the gripper does not recognise it as a graspable object.

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Proceed as follows in order to create a gripping point:

1. Select the Basic subfolder for the Box4 object.
2. Select New and Gripping point from the context menu.
3. A gripping point appears in the right-hand window.
4. Select the gripping point and open the properties dialogue box from the context menu.
5. Select the object coordinate system and position the gripping point at the centre of the workpiece.
6. A gripping point range can then be created in the “General” index card.

In addition to this, you can import any of the workcells and elements included in the model library. However, you must keep in mind that existing I/O connections are not imported. You’ll have to set up the I/O connections again after import. This process can be easily elucidated:

Creating I/O connections

Open the BP70 workcell and the model explorer. Select the SimuBox object and the inputs subfolder in the LED_0 object for the SimuBox. A display appears in the right window indicating that the “On” input is connected to the “OUT0” output. Click the “On” input and select the function **Edit → Remove Connection** in the context menu.

Task

Connect the “On” input at LED_0 to the “OUT0” output at the robot controller.

Solution

Position the mouse pointer at the “On” input for LED_0 in the display window. Press and hold the left mouse key. Move the mouse pointer to the “OUT0” output at the robot controller in the navigation window of the model explorer, and then release the key (connect by means of drag and drop). The connection to the selected output appears in the display window.